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ABSTRACT

What factors have prevented the widespread educational application of the broad spectrum of communication technologies that have exerted such a profound influence on other segments of our society? Is the greater use of technology in education indeed desirable? This study addresses itself to these and other questions. The basic premise is that technology is a means to an end and that any consideration of the issues raised by the existence of this resource must start with the problems and needs of our educational system. The focus of this book is on the political, social, and technical forces that bear on the development of educational technology, and on how educational technology can be shaped to meet the changing needs and expectations of society. Issues and public policies are analyzed, together with suggested courses of action to help form a basis for making technology a more responsive and effective tool of education. (WCM)

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# ISSUES AND PUBLIC POLICIES IN EDUCATIONAL TECHNOLOGY

## TO REALIZE THE PROMISE

Advisory Committee on Issues in Educational Technology
Commission on Education
National Academy of Engineering

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
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# ISSUES AND PUBLIC POLICIES IN EDUCATIONAL TECHNOLOGY

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## PREFACE

> For all my doubts and misgivings, I look forward to the time when the quality of American education at all levels can catch up with the quantity, and I do indeed believe that there is at least a gambler's chance that technology will help bring that event about. But to get us from here to there is going to require a giant effort in research and development by the best heads we can get to work on the problem.
>
> --James Koerner*

This planning study was undertaken in July, 1971, at the request of the U.S. Office of Education by an advisory committee of the Commission on Education of the National Academy of Engineering. The purpose of the study was to generally (1) identify some of the major issues and problems in education today, (2) relate these issues to public policy, and (3) specifically to make recommendations regarding the role of the federal government, particularly that of the Office of Education, in the constructive and innovative uses of educational technology.

The task has turned out to be enormously difficult. By their very persistence, the problems that beset education as they relate to society

*Program Officer, Sloan Foundation, in Saturday Review, Supplement on Educational Technology, May, 1973.

as a whole are immensely complex and not susceptible to easy definition and solution. Moreover, educational technology of itself is a very large, swift-moving field consisting of many diverse elements. Thus, the inherent difficulty for any study which undertakes to relate the issues in education to technology is comprehensiveness as well as pertinence.

To this end, an ad hoc Advisory Committee created by the Commission on Education, and its staff conducted scores of interviews with knowledgeable persons in education, the educational technology field, and the government, to obtain their views and expertise. A large number of resource documents were assembled and studied; also several ad hoc papers were contributed to the Committee. In particular, the Advisory Committee has benefitted from previous studies of educational technology by the Commission on Education, including the 1969 report "Educational Technology in Higher Education--the Promises and Limitations of ITV and CAI."

The Advisory Committee, for its part, established four Task Forces and several ad hoc committees and working groups to facilitate its study. Many meetings of the sub-groups were held in addition to a dozen formal sessions of the full Committee. All members of the Committee contributed a great deal of time.

The study has benefitted from the dedicated assistance of Jean P. Moore and Annemarie O'Quinlivan of the staff of the Commission on Education, and Vivian Cardwell of the College of Engineering at the University of Illinois at Chicago Circle. Dr. William K. LeBold was Staff Associate for the project for one year in the office of the Commission on Education.

A special acknowledgement is due William E. Howard for his advice and labors as both consultant and the editorial director in compiling and writing this report.

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## INTRODUCTION

What are the issues which generally have prevented the widespread application to education of the broad spectrum of communication technologies that have exerted such a profound influence on other segments of our society? Is it indeed desirable to make greater use of technology in education? If so, what should be the level of usage? And how can it be obtained? What are the implications for public policymaking bodies in dealing with these issues? For educational institutions? For the education consumer? For industry and for technology? For society at large?

This study addresses itself to these questions. Our basic premise is that technology is a means to an end and that any consideration of the issues raised by the existence of this resource must start with the problems and needs of our educational system. Education in recent years has been endeavoring desperately to cope with two major pressures: the rapid growth in cost that has strained the willingness of the taxpayer to pay for education, and the increasing expectations for education as a means for satisfying a number of demands in our society.

Previous studies have enumerated the great potential of educational technology. The report of the Commission on Instructional Technology[1/] has stated its conviction that "technology can make education more productive, more individual and powerful, make learning more immediate,

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1/ Tickton, S. G., edit. "To Improve Learning: An Evaluation of Instructional Technology," Part I - Report of the Commission on Instructional Technology (McMurrin report), with recommendations, Part II - Selected Working Papers, R. R. Bowker & Co., (N.Y. and London), (1970).

give instruction a more scientific base and make access to education more equal." More recently the Carnegie Commission on Higher Education[2/] has predicted that "by the year 2000 it now appears that a significant portion of instruction in higher education on campus may be carried through instructional technology...[and] certainly will penetrate much further than this into off-campus instruction at levels beyond secondary schools--in fact it may become dominant there." The Commission observed, however, that educational technology was coming along more slowly than expected, was costing more money and was adding to rather than replacing older approaches.

We believe, with both of these earlier studies, that the potential contribution of technology to education remains great. But we are not optimistic about the potential being realized in any reasonable time scale unless a much more concerted effort is made now to resolve a number of interrelated issues. Given the enormous complexity of the field of educational technology we have, as a means of simplifying our analysis and discussion, separated the issues into three groupings: issues that are predominantly of a public policy nature, issues that are predominantly of a technical nature, issues that are predominantly of an educational nature. As the reader will find, these classifications are not altogether clear-cut.

Our objective has not been to dwell at length on many issues of a predominantly educational nature, that have been examined at length in

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[2/] Carnegie Commission on Higher Education. "The Fourth Revolution, Instructional Technology in Higher Education," a report and recommendations, McGraw-Hill (NYC), (May 1972).

previous studies. Rather it has been to relate these issues to underlying technical problems, and to explore ways of resolving them through new or existing public policy mechanisms.

In inventorying issues and needs, we have not attempted in general to go much beyond their identification. Intriguing as it would have been, for example, to undertake an in-depth review of all available technology hardware and software for education, such an inquiry would have been far beyond the scope of this study.

In brief, our focus is on the political, social and technical forces which bear on the development of educational technology, and on how educational technology can be shaped to meet the changing needs and expectations of society. We hope that the following analysis, together with suggested courses of action, will help form a basis for making technology a more responsive and effective tool of education.

## SUMMARY OF FINDINGS AND STRATEGIES

American education is changing. New directions are being explored to respond to societal demands to make the teaching-learning process more economic, yet provide greater access to better-quality instruction and aid the disadvantaged. One of the principal options open to achieve these goals is the wider application of the complex of technologies and techniques - from communications technology to systems analysis to computer-assisted instruction - which comprise the field of educational technology. Unfortunately, educational technology is not yet at the stage of development where it can be easily integrated into our schools and colleges.

Nevertheless, it is the overall conclusion of this study that our society should exercise its technology option in education now and set about the formidably difficult task of making it work.

## FINDINGS

* We believe that one of the mandatory first steps is the creation of public policy mechanisms to allow citizens to make informed decisions as to the direction the development of educational technology should take. There should be meaningful citizen involvement in the entire process, from research to operational usage, to ensure that technology is moulded to serve human needs in a humane fashion. The responsibility for these decisions cannot be left to the federal government alone, but should be shared by appropriate state and local bodies, by industry, by citizen groups, and by educators.

* At the federal level, at present, the supportive role of the Office of Education in assisting educational technology to become a coherent, scientifically-based field is too tentative and weak and has been marked by more failures than successes. A higher degree of professionalism is needed in the management of government programs. Congress for its part, has not been persuaded by the USOE or other advocates of educational technology that it does have a greater contribution to make in strengthening the federal role.

* There is considerable danger that budgetary restrictions will undermine the staging of meaningful demonstrations to adequately test educational technology in both an economic and educational sense.

* Not enough attention has been given to the importance of research findings which have been interpreted to conclude that students taught by television, the computer, and other media demonstrate no significant difference in achievement than control groups taught by a teacher. Some authorities have challenged the validity of these experiments. But nonetheless no-significant-difference findings do raise important questions for state and regional policy makers as to whether technology can be applied to achieve lesser costs, greater individualization and diversity of schooling--particularly in the creation of new "open" educational systems to reach learners outside the formal educational system.

* Presently, in excess of $1 billion a year is being spent by educational institutions on various types of instructional media involving

technology, but virtually no validation of the materials is being performed. Moreover, there is very little evaluation or assessment of the impact of technology-based programs where they are now in operation.

* Development and distribution of high-quality course materials for existing institutions and for the new "open" systems are clearly affected by controversies over copyrights. A new public policy is required to encourage the creation and dissemination of learning materials by all types of media while protecting, through a fair payments system, the rights of the creators.

* The formulation of better policies and strategies to attack difficult educational problems and needs is being hampered by a lack of systematic analysis of the problems. Likewise, not enough study is going into the solution of technical difficulties inherent in making educational technology a viable and integral part of instruction. As a result, there has been no definition of the multitude of priority tasks that need to be accomplished to resolve technical developmental problems, and no timetables have been drawn up as to when specific technologies can be phased into educational systems.

* A systematic approach is called for to bring about the creation of consistently high quality course materials for the users of technology that are now lacking. This approach, which begins with continued investigation of how people learn, should range from analysis of learners' backgrounds to testing and evaluation of acceptability.

* "Piggybacking" of educational applications by producers onto technology developed for other purposes and a lack of coordination of institutional purchasing policies have adversely affected the marketplace for meeting the technological needs of education. A lack of consumer information and standards is preventing present and potential users from buying technology components and materials most suitable for their needs. These users are being saddled with equipment that freezes them into single presentational formats (e.g., different size film and video cartridges) and devices which break easily.

* The lack of clearly defined markets also has restricted industrial research and development of devices for educational purposes. Furthermore, the development of better instructional materials is being delayed by insufficient knowledge of the basic learning and individual motivation processes.

* A further inhibition to development and dissemination of improved courseware derives from a federal policy that assigns most of this work to academic institutions. The resources and talents of the profit-making instructional materials industry are under-utilized.

* The time is at hand to determine whether it would be more efficient and at least as effective to provide more services to more people through a national telecommunications network dedicated to education. The growth of state and regional television, radio and computer networks poses a question as to whether there are advantages in interconnecting these systems.

* Technology can play an important role in making education more productive in the sense of allowing the system to be more flexible, by opening up more learning options for more people. Unquestionably, one of the biggest potential contributions technology can make is in providing virtually unlimited numbers of Americans with access to education of their choice. The roles of television, radio, cable TV, computers, etc., have been barely explored in this respect - a fact which the Committee finds alarming in light of recent attention by the federal government concerning the promulgation of guidelines and regulations relating to the allocation of public and educational cable TV channels.

* Technology also makes it possible to achieve economies in certain phases of schooling, for instance through the employment of television for lectures and of computers for drill-skill lessons. When developed as an integral part of new institutions, such as the "open" universities, technology can bring about substantial savings, by reducing the need to acquire real estate and erect buildings. If integrated to a significant degree in existing institutions, technology can allow a reduction in teaching staff. However, this saving is likely to be offset by the costs of the instructional hardware and software and by the fact it would be necessary to pay staffs higher salaries commensurate with higher skill levels required to manage technology-based educational systems.

* With technology, it should be possible to remove some of the cultural and economic barriers that spell inequality in education today, simply through making higher quality materials more available. There is

an opportunity to aid the disadvantaged, if research can produce materials that will compensate for learning deficiencies attributable to nutritional impairment, deprived home environments, and a lack of motivation.

* However, to realize all of these potentials will take more than developing and validating educational hardware and software. Engrained behavioral patters which tend to make human beings resistant to change must be overcome. The application of technology will entail a significant alteration of the traditional teaching-learning environment. For technology to succeed in achieving its promise, a majority of Americans must become convinced that the new way is the better way - and this may be the most difficult task of all.

## RECOMMENDED STRATEGIES

For our society to deal with the myriad decisions necessary to first develop and then apply technology to education, it is essential that new public policy mechanisms be established. We recommend the following steps which are presented in the order in which they appear in this report.

1. Creation of State Councils of Educational Technology with the mission to assist in the development of policies that will facilitate the application of technology to all educational activities in the states where it is efficacious to do so. The Councils should provide policy and systems studies, assist courseware development and teacher training, recommend demonstration projects and disseminate technology information. The Councils would direct their advice to boards of education.

2. Creation of a National Open Education Corporation with the mission to assist in the diversification of American education. The Corporation should be a mechanism to facilitate freer access to educational opportunities - both in existing institutions and the new "open" schools and universities - while retaining the coherence of the educational system as a whole. Specific roles for the Corporation would include assisting in the development of standards of compatibility in the networking of state and regional educational communications linkages so that they can be extended nationwide; coordination of course materials development and dissemination; development of criteria for effective courseware; and providing for other informational and technical expertise. The Corporation would report to Congress and the Secretary of HEW through the Assistant Secretary for Education.

3. Establishment of a National Commission on Information and Standards for Educational Technology to report to the Director of the National Institute of Education. With a membership drawn from technology users, producers, government officials and taxpayers, the Commission would be charged with providing specific recommendations for developing uniform standards of quality and performance in educational technology software and hardware, and with providing a system for accurate consumer information.

4. Encourage Congress' new Office of Technology Assessment (OTA) to take the responsibility for monitoring the impacts of educational technology on societal development - and vice versa. The OTA should consider providing the nation with in-depth reports on specific aspects of the problem, as well as periodic overall assessments of the probable directions educational technology should take.

In order to facilitate the resolution of numerous technical problems associated with the development of educational technology, we further recommend that:

5. The National Institute of Education (NIE) have sufficient funds made available to it to support the planning and production of pivotal course materials for all educational levels. The design of such materials should be based on the systems approach - including analysis of learners' backgrounds and needs, specification of desired learner competencies, and the provision of options to meet the interests and goals of individual learners.

6. The NIE establish a long-range and broadly conceived program of basic research in those aspects of science and engineering which promise major innovations in educational technology.

7. Significant funding on the order of $30 million to $50 million a year, be made available to the NIE to carry out complete and meaningful demonstrations to test the economic and educational efficacy of technology-based instructional systems. The NIE also should be given authority to make grants-in-aid for the development of "open" educational systems.

8. The Federal Government reexamine its policies to permit private, profit-making companies to be employed as prime contractors, either alone or in consortia with academic institutions and government agencies, in programs to develop innovative instructional materials and methods.

9. The proposed National Open Education Corporation and the NIE launch a comprehensive study into the need for and the feasibility of a national telecommunications network dedicated to educational purposes. The study should encompass all existing educational communications networks

and examine all promising alternatives and engineering methodologies.

10. A categorical program of the NIE be funded at a sufficient level, and with a guarantee of support for a sufficiently long period of time, to provide research and pilot studies as to how technology can be effective in the delivery of education, including vocational education, to the deprived, the handicapped, the unemployed, and the underemployed, and that the proposed National Open Education Corporation be mandated to consider from the beginning of its operation the delivery of education to these groups.

11. An independent mechanism be created to evaluate the effectiveness of major educational technology experiments and demonstrations sponsored by the federal government. This mechanism could take the form of a special commission or be part of an existing agency or department as long as it is entirely separate from the operators of the experiment. It should be staffed and organized to provide completely objective evaluations for the funding agencies and Congress.

## Chapter II

## PUBLIC POLICY ISSUES

For the better part of the past decade the federal government, principally the U. S. Office of Education, has been heavily involved in applying technology to teaching and learning--but in a fragmented way. Currently there are more than 30 legislative acts and titles being administered by the USOE to fund educational activities involving television, computers, radio, film, print and other technologies. Precise spending data has never been published covering all the dispersed programs. Probably in the neighborhood of $1 billion (including cost sharing by states) was budgeted in Fiscal 1972 for instructional materials, media, and media-related activities. Most of the programs were directed at improving services to the physically and educationally handicapped and providing more training in vocational fields.

While the involvement of technology is substantial, it is difficult to ascertain how much of the budgeted money was spent, or where, or to define spending patterns for prior years.

It is also all but impossible to determine to what degree these technologies have succeeded in solving problems to which they have been addressed. Very little evaluation and assessment of technology programs has been done. In short, educational technology is a submerged object of diffused proportions.

### Major Concerns

Nonetheless, the use of technology in education is a major public concern--from the standpoint of future public commitment to support

existing programs, to adopt new educational systems and to manage them effectively. The underlying reasons for the emergence of this concern can be summarized as follows:

1. Education, at every level, is being affected by rapidly increasing costs. There is a prevailing demand to make the system more "productive" while spending less money, or at least to lower the rate of annual per pupil cost increments.

2. Greater burdens are being placed on the educational system. Educational systems are being asked to provide improved services for the disadvantaged; to improve the quality of the teaching-learning process; and to offer a greater variety of learning opportunities to more people.

3. The federal government is debating whether to shift more of the responsibility for determining how the educational dollar will be spent to state and localities, as well as directly to the students as consumers.

Productivity

In each one of these areas, technology already is or could become a very important element. For example, the OE-supported Sesame Street and The Electric Company television programs for young children are being broadcast into millions of homes and thousands of classrooms, teaching the alphabet and other concepts in a lively and entertaining fashion. These programs have not yet added to teacher productivity, in the sense of reducing teaching costs, although they may enable teachers to make much better use of their classroom instructional time. But it has been shown that a television program, properly constructed and executed, can be a vehicle for learning on a large scale at low per pupil cost.[1] It is

1/The U. S. Office of Education estimated in 1972 Sesame Street and The Electric Company together cost $1.29 per pupil per year.

extremely significant that children watching the programs by themselves at home can learn through this medium. It demonstrates one way that television can open up the formal educational system.

The two programs were not intended to reduce school teaching costs. But they pose the question: what would schools do if more programs were developed which taught entire courses and took up most of the school day? Could there be a restructuring within the schools to use teachers more effectively to diagnose and work with individual learning problems? Could teachers handle more than the normal class of 25-30 students? Or will in fact the increasing sophistication of learners lead them to demand smaller classes and more personalized attention? Could teachers employ TV-telephone systems to reach still more students outside of school?

The Commission on Instructional Technology[2] has documented how other media as well as television can help do all of these things, and much more, to make America's school system more productive in both a qualitative and an economic sense--provided that the necessary course materials (software) are developed and such institutional barriers as academic lockstep policies and resistance by teachers are overcome. These two provisos in themselves involve enormous difficulties of an educational and technical nature which are discussed at length later in this study. Indeed, the difficulties are so severe and the effort required to resolve them of such magnitude that they demand public policy decisions which until now have received scant attention.

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[2/] To Improve Learning, Op. Cit.

The Disadvantaged

A case in point is the effort by government leaders to aid the disadvantaged through improved educational opportunity--efforts which are still under way despite the failure of many school reforms in the 1960s. Coleman[3] made the controversial finding that schools do not make a difference but the home environment does make a difference in educational achievement. Whether or not one agrees that those born to poverty can benefit from education only to the degree that they improve economically and culturally, it is obvious that alternative ways to assist deprived youths to lead more satisfying lives have been barely explored.

One might ask, for instance, why much greater use has not been made of the audio-tutorial method for stimulating learning of language skills. The availability of tape players is not the issue, but the availability of materials to play on them to help a potential high school dropout speak and read better is. The software to communicate this and other types of learning to individuals of varying ethnic backgrounds has not been developed. But it probably could be, if a public policy decision were made that it should be done. One might ask why learning centers are not being created in public housing units to teach youths marketable career skills, by employing the tools of instructional technology. Again it is a matter of public policy decision to perfect the software for a specific type of learner and make it available in a context where it will be utilized. This is not to suggest that techniques such as this will significantly impact the overall problem of educating the disadvantaged,

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3/ Coleman, James S., Equality of Educational Opportunity, National Center for Educational Statistics, 1966.

but rather to indicate how technology, or the lack of it, is an issue in this area. A more complete exploration of this problem, together with recommended strategies, is contained in Chapter IV.

Flexibility: The Dropouts

Unquestionably, one of the most critical problems confronting American education is how to make the whole system more flexible and adaptive to the needs of learners of all ages and backgrounds. That the system is failing to achieve this necessary flexibility is apparent in the fact approximately 850,000 youths--one in every four--drop out each year before graduating from high school.

Not only have they failed in many cases to learn marketable skills, but they acquired powerful generalized aversions to schools and to later learning. Some youths leave school early for lack of aptitude, but many more have abilities to learn that the formal educational process simply ignores.

An estimated 750,000 youths who do receive a diploma each year are unemployable, or suited only for low-paying jobs. The prospects of another 850,000 who drop out of college are not much better to cope with changing job requirements.* Obviously, the manner in which schools offer instruction is greatly in need of improvement, but how to accomplish this long has eluded educators. They have tried one-shot applications of technology with varying success. At some levels, such as teaching basic

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*This breakdown of 2.45 million students who left the formal education system in 1970-71 was cited by the President's Commission on School Finance in its March, 1972, report.

language and mathematics skills, progress has been made with individualized instructional techniques employing technology. However, technology's capacity to provide alternate learning modes, to capitalize on hidden learning abilities has not been explored to any great degree. The fact that technology has not been used on a wide scale to cope with the problem of pupil retention is an issue deserving much more public attention than it is presently receiving.

Flexibility: Opening Up the Educational System

Yet another major policy question concerns the opening up of the educational system to serve those economically unable to acquire the learning they need or whose access is otherwise restricted, such as the physically handicapped and the institutionalized. The number of people seeking adult and continuation education is constantly increasing. The pace of society is requiring almost everyone to seek new training or retraining periodically and this constitutes a great unmet demand upon the educational system. It is probable that the nation is approaching the point where every five years almost everyone in the adult population should receive additional education. If 20 million persons were to be served each year by 1,000 hours of conventional instruction at $1 an hour,

it would add $20 billion to the educational bill.* However, as long as the cost is that high, it is unlikely that the demand will be met. But it is possible that the costs of providing that instruction could be made much lower by developing courses that would be delivered by television or radio for new institutions like the Open University of Great Britain and a few open systems now being created in this country. More access is possible through distribution by cable TV, libraries or other centers containing the materials in film, audio and print form. The difficulty is that neither the dimensions of this need nor the means to fulfill it are being subjected to sufficient public scrutiny.

Citizen Involvement

The examples cited above indicate there is a large area that needs prompt attention by decision-making mechanisms on the citizen level to lend direction to the application of technology to educational problems.

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* These figures should not be taken too seriously, but they do have the following reasoning behind them. One dollar per student-hour is an approximate figure which shows up (within a factor of two) in many spheres of education. It is a target figure for computer based education. (Education in elementary and high schools costs approximately $1,000 per pupil per year for a 1,000-hour school year, about 200 days X 5 hours per day). The figure of 20 million adults was arrived at by estimating that each working adult will need about 1,000 hours of instruction every five years. We could have said that each working adult needs a tuition fund of $1,000 every five years (or $200 per year by distributing the educational load). The figures can be made more precise, but they are intended here only to arrive at an order of magnitude for the amounts needed in adult education.

That these mechanisms are presently not available, in itself, is a major public policy issue that is bound to become more acute as time goes on. While many states are currently using technology in their schools and colleges, few if any are organized to assess their requirements for technology, or are they in a position to employ technology to its greatest effect on the basis of operational research and systems analysis.

As noted earlier, the federal government is considering whether to shift more control over educational spending to the states through "special revenue sharing" or possibly some other device. Should this occur the states and localities would be forced to assume closer management of technology-using programs for the handicapped, vocational training, etc. It would appear prudent, regardless of what the federal policy becomes, for states to take affirmative steps now to bring the application of technology under their control.

## FEDERAL POLICIES

Further understanding of the rather amorphous way public policy is handled in educational technology may be obtained by a look at federal policies. The Office of Education's position has been to support technology where it promised to satisfy a particular educational need. The Office has not attempted to develop the field into a coherent, scientifically-based entity until very recently.

The National Center for Educational Technology (NCET), which began functioning in 1972, was given the mission of coordinating all the technology programs of the Office of Education. It also was to become the "national focus" for educational technology, define public issues,

encourage states and localities to apply the benefits of television, computers, etc. as researched and approved by the National Institute of Education, and various academic organizations.

Legislative Strategy

The NCET has sought legislation in Congress which would enable it to carry out a rather comprehensive "five-year strategy." The main projects involved in this strategy include:

1. Comprehensive demonstrations for local, regional, or state educational systems willing to adopt technological alternatives "in order to improve educational productivity." Funds were requested for three to six regionally-situated demonstrations which were to be carefully designed and evaluated.

2. Support of nationally relevant TV programs and educational courseware that would build upon the work of the Children's Television Workshop which launched Sesame Street and The Electric Company. From 5 to 15 grant awards of $2-4 million per year were to be made for program production.

3. Support for three or four major demonstration projects which would rely on telecommunications equipment, such as communications satellites, to deliver educational, cultural, and instructional programs to remote, isolated areas, plus serving minorities and others in out-of-school programs.

One of the legislative measures currently sought by the agency to further its strategy is an "Educational Technology Act" to assist the application of technology in pre-school, elementary, secondary, and higher

education. Ninety percent of appropriated monies would be apportioned among the states for planning, training, acquisition and implementation and would cover materials and equipment. The remaining 10 per cent would be administered by the NCET for research projects. States would also receive funds for technical assistance to local educational agencies, including preparing and disseminating information, and evaluating projects.[4/]

When this measure was first introduced in 1969, well before the establishment of the NCET, it proposed to authorize an annual appropriation of $200 million for elementary and secondary education and $100 million for higher education. When it was re-introduced in 1971 and again in 1973, as HR 3062, the proposed dollar ceiling was eliminated. Instead, the bill authorized the appropriation "of such sums as the Congress may deem necessary." But this change did not attract more interest in the measure and at this writing it still had not been acted upon.

The NCET also has sought enabling legislation in the telecommunications field, again with limited success. The draft legislation would:

--Strengthen OE's ability to support the installation of both broadcast and non-broadcast hardware, including open-circuit radio and television; communications satellites, cable TV, Instructional Fixed Television Service and other means of allowing more efficient and widespread delivery of educational programming of all types.

--Provide authority to research and develop instructional software

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4/ "Section-by-Section Analysis of the Educational Technology Act, H.R. 3062 and related bills." Committee on Education and Labor, U.S. House of Representatives, 1973.

for in-school use, at all levels, as well as for home audiences. It also would permit development of software for delivery by any type of telecommunications, from television to computer to audiovisual.

Limited authority has been granted by HEW to allow the OE to work with state, local, and other educational groups in developing comprehensive demonstrations of promising applications of telecommunications to education. Current examples are NCET projects to broadcast educational programs via satellite to remote communities in Alaska, the Appalachians, and the Rocky Mountains, and the SUN Open University in Nebraska.

Finally, the NCET has sought authority to strengthen state public telecommunications agencies through grants so individual states can coordinate the development and installation of educational systems. But such authority has not been approved by the Secretary of Health, Education and Welfare.

Current Trends

In the Fiscal 1974 budget the Nixon Administration proposed a special program of "educational revenue sharing" which would turn over the management of $2.5 billion in elementary and secondary education programs to the states. Included in the proposed turnover are programs for educationally deprived children, education for the handicapped, vocational education, and adult basic education--all programs heavily infiltrated by technology.

New funds to demonstrate the effectiveness of elementary and secondary career education were programmed at $14 million. However, the budget drastically reduced funds for teacher training (there are now 75,000 surplus teachers) and eliminated categorical aid for school libraries.

The NCET would be deeply affected. The Administration proposed to halve the agency, shifting its $17 million in discretionary research program funding to the National Institute of Education, and allow the center to run about $10 million in operational programs, including Sesame Street and The Electric Company. (Funding for the latter two programs is being reduced from $6 million to $3 million because they have become more financially independent through royalities from the sale of books and related materials.)

The Educational Broadcasting Facilities program, which has supported construction of educational television and radio stations, was reduced from $13 million to $10 million. The justification was that educational broadcast outlets are now near the saturation point. However, this narrow view of outlets does not encompass computer-based instructional networks, cable television and CATV, which presently do not figure prominently in government-sponsored education programs.

Implications

From the viewpoint of current legislative and budgetary trends on the federal level, two implications are apparent:

1. Funding for development and application of educational technology is being cut back and its potential is in danger of being ignored.

2. No proposals are being advanced to aid the states to better organize resources already utilizing technology for education; no provision is being made to elevate standards for media software and hardware in conjunction with industry; coordination of technology-using

programs across the nation is still lacking.

The main impact of the Fiscal 1974 budget proposals, if enacted, will be to greatly reduce the Office of Education's role as a prime force in expanding the use of technology. It is difficult to assess whether such a change will work out for the better or worse in the long run. Some critics point out the OE has proven to be ineffective in the past in this area and allege insufficientprofessional competence and leadership. In any case, plans for shifting spending responsibility to the states for technology programs through "educational revenue sharing" does underscore the need for creating local (state and regional) mechanisms with the competence to fill what otherwise can become a policy-making vacuum.

On the other hand, the concentration of educational research in the National Institute of Education is a step in the right direction to achieve a "critical mass" of effort that is greatly needed. It is imperative that the NIE does not de-emphasize research and development in the technology area, however. This agency is still undergoing its birth pains. It is to be handed approximately $100 million in on-going research and development programs transferred from various parts of the Office of Education and the Office of Economic Opportunity.

In its budget directive, the NIE has a mission to conduct basic studies to strengthen the scientific and technological foundations of education; to build an effective R&D system which also links research findings with users; and to mount "fairly large-scale" demonstration projects intended to help solve major educational problems. However, the Fiscal 1974 budget calls for only a total of $50 million to support this entire mission.

There should be a major national concern lest shortsightedness accompany the shortage of money. In the past, and in the present, there has been a tendency to design a technology demonstration project to fit

the money available for it, rather than design a project to solve a major problem and fund it as required. The end result has been the conduct of a number of marginal experiments, lacking adequate provision for evaluation and some important component such as equipment, training or validated materials, and only a relatively few successes like Sesame Street. The NCET and the Commission on Instructional Technology have suggested demonstration projects involving entire school districts and many thousands of students. It is possible that to thoroughly design, implement, and evaluate just one such demonstration might cost $50 million. Where is this money to come from?

It is difficult, of course, to know how the NIE will evolve its plans, or what future funding for the agency will amount to. But there does appear to be a danger of repeating the mistakes of the past and Congress should carefully evaluate the NIE's budget and objectives in this light.

There is a further problem with the NIE mission. It is bound to be very difficult for the NIE--or any purely governmental agency--to grapple successfully with the myriad public policy issues, and coordinate diverse academic interests with industry to increase the flexibility of the educational system. Indeed, given the present mission of the NIE, the creation of some independent national mechanism that will truly represent the public's interest and anticipate the needs of society becomes even more necessary. Such a mechanism is needed to complement the NIE and insure that the product of research--and technology--will reach potential users across the country and will stimulate the opening up and improvement of the educational system.

## Summary of Public Policy Issues and Needs

### Policy Mechanisms

Before any rational decisions can be made as to the future development and application of technology to education, clearly appropriate bodies must be created at the state, regional and national level. These bodies should be comprised of representatives of the general public, educational authorities and technical authorities. In general, it makes both educational and political sense to place as much control as possible over technology in the hands of those who have direct responsibility for its use.

It is equally necessary to insure that there will be an interconnection of local, state, regional and federal policies and activities covering educational technology. Physical, legal, organizational and conceptual interconnections will determine how our educational system can use educational technology to cater to the diversity of needs in our society while operating as an organic whole.

### Basic Learning Theory

In defining the public policy-making issues, it is essential to correlate a very basic educational concern, and that is: educational technology cannot be ultimately successful until research discovers more about the learning process, how it varies from individual to individual and under what circumstances (e.g. group vs. individualized instruction). There is clearly a need for this basic knowledge, particularly as it relates to learning with the new media, for without it policymakers would be making choices in the dark. It raises this issue:

In the absence of proven learning theory, should the application of a given technology in education be postponed? An examination of this question leads to the conclusion that postponement would be a mistake. One primary reason is that only through applying new media and testing them will the necessary feedback be obtained to develop the theories. The situation is somewhat analagous to development of the airplane; the first ones flew long before the theory of aerodynamics was fully understood and proven. The issue over learning theory and the new media is not whether students actually learn, because they do, but whether use of the media is equal to or represents an improvement over traditional teaching methods.

In this regard, there is evidence that students taught by television, the computer and other media show no significant difference in achievement than control groups taught by a teacher.[5] This finding long has been given by some as a reason for not using new media, especially if it increases teaching costs. But there are positive consequences as well. As pointed out by Oettinger and Zapol, the findings show that "learning is largely independent of the details of means, hence that issues of policy and technology, on the one hand, and of learning method and content, on the other hand are essentially independent. No-significant-difference findings, therefore leave alternatives to the accepted ways of schooling wide open, alternatives that might, according to public preferences,

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[5/] C. R. Carpenter and L. P. Greenhill, Instructional Television Research, University Park, Pa., Pennsylvania State University, 1958, p. 18. Paul Saettler, A History of Instructional Technology, New York, McGraw-Hill, 1968, Chapter 15.

achieve lesser costs, greater individualization, or some other personal or social benefit without, at the very least, making any difference so far as measurable learning performance is conceived. These benefits are neither all equally attractive to everyone nor unequivocally measurable. Preferences and priorities keep changing. Acceptable strategies for making technology responsive to learning must therefore permit continuing and diverse public choices; decisions about ends and means must be reserved as matters of public policy and not left unattended to experts. (Emphasis Added). The strategic question of how technology affects control over the means of learning must take precedence over pedagogical nits to assure that public preferences--or significant differences, if some are ever found--will be accommodated and not dictated by how technology is deployed."[6]

Some authorities in the educational technology field have serious reservations about the validity of the experiments which arrived at the no-significant-difference conclusion. But whether or not one accepts the conclusion, the indisputable point emerges again--public mechanisms are needed to allow citizens to make informed decisions over the use of technology in learning.

Proving by Demonstration

Two main barriers have contributed to the fact that technology has not found acceptance as an integral part of education: it has not been thoroughly tested in the educational context, and it has not been adequately tested in the economic sense.

Thus there is a public policy issue over the question of spending sufficient funds to mount demonstrations which will realistically

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6/ Oettinger, Anthony G., Zapol, Nikki, Will Information Technologies Help Learning?, McGraw-Hill, Copyright 1972, The Carnegie Commission on Higher Education.

explore the dimensions of technology's potential in education. The design of these demonstrations must be guided by local, state and national needs as perceived by the appropriate public bodies. There is no point in staging a demonstration unless it is to show that a clearly defined need is to be met. Moreover, these demonstrations must be evaluated by unbiased, independent parties to determine whether the objectives are met.

Systematic identification of pertinent research needs, based on feedback from local, state and regional levels; engineering, economics, political science, the management and establishment of appropriate research and development and evaluation policies are all part of this issue.

Another aspect of conducting demonstrations--and the carry-through application if successful--is the involvement of industry. Policy decisions must be made as to how industry could play a more effective and responsible role in the development of software and hardware and in the operation of educational support systems. This issue is discussed in greater detail in Chapter III.

Technology Assessment

Hand in hand with the application of technology is the question whether it is indeed achieving desired goals in the best interests of society. The issue of assessing where technology is taking the nation is very pertinent in the field of education. For example, there is evidence that affluent students and school systems acquire and use more sophisticated technology than economically disadvantaged students and school systems. If assessment studies show that greater exposure to technology results in superior learning opportunities, an economic advantage would introduce still more profound, educational imbalances

between rich and poor systems. This evidence would then highlight the need for compensatory action and encourage the initiation of appropriate programs.

Revising Copyright Laws

Informational technology has encountered a major impasse over the protection of copyrighted material. Congress currently is debating revising the Copyright Act and the outcome will hold major implications for educational technology. The impasse threatens to inhibit development and distribution of high quality courseware. The problem lies in the ability of technology to interchange information and disseminate it in diverse modes. The photocopying machine is one of the major devices for reproducing printed material without the control or permission of the publisher and author. Computers can store and utilize print materials; video tape can store and reproduce film; cable and community antennae television systems can extend the distribution of copyrighted materials beyond commercial broadcast limits.

The issue as it relates to educational technology concerns the availability of services to learners, the cost, who should pay and who should determine both availability and cost. A new public policy is needed which will encourage the creation and dissemination of learning materials by all types of media while protecting, through a fair payment system, the rights of the originators.

## NEW PUBLIC POLICY MECHANISMS

An examination of the public policy issues and needs leads to the

conclusion that new decision-making mechanisms are now required by society to deal with the development and application of educational technology to existing institutions and to assist in the establishment of new institutions to fulfill unmet demands.

At least three mechanisms should be created by law with well-defined authority to decide educational and technical issues and to interact with the educational system as a whole.

## STATE COUNCILS OF EDUCATIONAL TECHNOLOGY

In recent years the federal government has been increasingly concerned that funds directed at specific targets in the states and cities be used intelligently and effectively. In the Higher Education Amendments of 1972, Section 1202 calls for creation of state planning groups to coordinate programs and the allocation of funds, particularly in the overlapping areas of vocational, adult, and career training.

A logical extension of this state planning philosophy, which adheres to the principle of local participation and responsibility, is the creation of State Councils of Educational Technology. The Councils would have as their primary activities coordination and stimulation of the application of educational technology to all educational activities in the state where it would be efficacious to do so. They would:

--Provide policy and systems studies, surveys of educational technology activities throughout the state, and make inventories of resources.

--Facilitate development of courseware.

--Provide for teacher training, research on and evaluation of

applications of educational technology.

--Be responsible for disseminating technology information.

--Recommend demonstration projects.

The Councils would be composed of members of the public; highly qualified members of the educational community, including teachers and administrators; educational research professionals, designers, planners and evaluators; and have access to commercial producers of educational materials and equipment.

There are a number of benefits that would accrue from these councils. In the first place, systems approved and monitored by the Councils would acquire the creditability and visibility necessary to facilitate the effective use of technology.

Secondly, the Councils, which include users throughout the state, can provide effective communication between the users of developments in educational technology, and the government or commercial agencies responsible for the innovations. This communication at present is very inadequate. Yet, in the deployment of new techniques it is imperative that word of how well the techniques work reach potential users, and that there be feedback from both actual and potential users to the developer at all stages of the process.

Another benefit arising from creation of the Councils stems from the fact that schools form a fragmented market for the producers of educational technology. Planning and use on a coordinated basis for many school districts, individual institutions, of higher education systems, would allow economies of scale. For example, some systems of educational technology would be able to benefit from sharing cable TV

and computer networks.

It is important that the Councils have the operational means to attain their goals to support educators in the field desiring to use technology. These means may be developed through a variety of arrangements depending upon the particular circumstances that exist in individual states.

It is vital that differences among states be recognized in recommending how the goals of the Councils may be reached in each state. In some cases there are very strong and centralized agencies at the state level through which the Councils may work. At the other extreme, there are instances where virtually no effective coordination or planning occurs at the state level. A graduated spectrum exists between these two extremes. Consequently, considerable flexibility must be provided in the mechanisms to be employed by the Council. It is helpful to discuss briefly some of the different kinds of activities taking place throughout the country to appreciate the many options available to the Councils.

Elementary and Secondary Levels: At this level a "learning resource center" is the new name for the local school library. In some schools the print materials in such libraries have been augmented by filmstrips, audio tapes and other non-print media and by the associated equipment that teachers need for the effective presentation of instruction. In other instances, carrells for individual learners have been provided, either as a part of the library or in a separate area where students can have direct access to audio tapes, slides, filmstrips, programmed texts, workbooks and other materials needed for individualized instruction.

In some schools, the audio-visual center, which provides films and projection services, has been combined with the library which heretofore had tended to concentrate on print materials. In other places these centers have been developed separately because they have required different types of personnel to enable them to fulfill their mission.

Generally, it is not feasible for such local learning resource centers to provide much, if anything, in the way of production facilities. Accordingly, in some school systems there are central audio-visual or learning resource centers which provide a variety of production services, e.g., video tapes, transparencies, slides, in addition to furnishing films from a central library.

Basically, such local systems provide point-of-use resources for teachers and students, modest supporting library services for print and non-print media, equipment and projection services and some assistance to teachers in the use of educational technology. There may be modest production facilities for transparencies, slides and video tapes, but it is usually not economically feasible to have extensive production facilities.

Regional Centers: There is room for substantial development of learning resource centers to serve school and college needs at the local level. However, it is not economically feasible to provide comprehensive facilities at every location. This has been recognized by the extensive development over the past few years of Regional Instructional Media Centers, principally to serve the public schools of their respective regions. As the use of high-cost technology, such as computers and television, expands, this sharing of resources becomes

even more important.

In a recent survey of regional media centers, Liberman indicates the types of services the centers can provide to local school districts. These may include: (1) film library services, (2) production of transparencies, slides, posters, charts, (3) duplication facilities for audio and video tapes, (4) technical repair services for instructional equipment, (5) television, radio and audio production facilities, (6) interconnection of television facilities for use by component districts, (7) development of professional staff of schools through workshops and other forms of in-service training, (8) consultant services to local districts to insure proper use of technology, (9) cooperative purchasing of equipment and supplies, (10) printing services, (11) professional library collections including curriculum guides and (12) specialized computer services such as cataloguing for instructional uses of computers via computer-assisted instruction.[7]

An example of the type of regional organization that could be developed are the Boards of Cooperative Educational Services (BOCES) in New York State, wherein a number of individual school districts cooperate to provide common services that none could undertake by itself. The services vary from centralized computer facilities for administrative (and potentially instructional) use to costly installations for vocational training. In certain instances production of some media materials have been undertaken.

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7/ Liberman, H.: Regional Media Centers--A Survey. Audiovisual Instruction, Vol. XVII, No. 3, March 1972.

While Regional Instructional Media Centers have grown substantially over the past 10 years with the combined aid of federal and state funds, there are considerable differences throughout the nation in the availability, scope and adequacy of the centers.

Coordination at State Levels: This is as varied as the different kinds of state education departments and various coordinating agencies. In some states a single agency coordinates all educational activities while in others separate bodies supervise and coordinate elementary and secondary school activities, and higher educational institutions.

Higher Education: At the level of higher education, somewhat the same types of learning resource centers exist as those described at the elementary and secondary levels. A number of institutions are developing "learning centers" equipped with carrells and appropriate hardware and software for individualized self-instruction. It is predicted that the need for this kind of facility will expand greatly over the next few years.

Some of the larger universities have quite comprehensive organizations to provide professional support for the institutions' instructional programs. Such organizations may include some or all of the following functions:

(1) Instructional research

(2) Course development assistance

(3) Production of instructional materials (films, television, audio tapes, computer programs, etc.)

(4) Library services (usually non-print media) and projection services

(5) Design of learning environments

(6) Evaluation of learning

(7) Demonstrations and in-service training services for faculty.

In other institutions these services are split up and uncoordinated, or are non-existent. Smaller colleges often have little if anything in the way of professional support for learning activities beyond a library and perhaps a modest amount of projection equipment, tape recorders and some associated films and tapes. What is lacking especially are professional people trained in educational technology who can work with the faculty in the design of study facilities. Possibly such professional support for small colleges can be most efficiently provided on a regional basis.

Another current development, namely the broadening of avenues for higher education for the adult, or part-time student, outside the normal institutional setting, suggests the need to examine the kinds of learning resource centers that are required to meet the requirements of this type of student. Perhaps existing school or college facilities can be used in the evening, or home-study centers may be required that have specific equipment and facilities to enable them to be connected with appropriate remote information resources.

Distribution of Produced Materials

There is, of course, considerable production and distribution of commercially produced instructional materials through the normal commercial channels. This can be expected to expand with increasing emphasis on systems of materials for individualized instruction. However, it is inevitable that schools and colleges will need to produce

some materials to meet their own special needs. While it is economically feasible to do this for low technology resources, it is only feasible for high technology resources if there is distribution and sharing of the produced materials.*

This suggests the need for improved means of sharing instructional television programs, either in tape form or through networks, for sharing computer resources, and for providing easy access by schools and colleges to computerized learning resources. Distribution of materials among learning resource centers and interconnection of such centers appears to offer important advantages. These apply also to other centers such as state education departments and the variety of institutions and cooperative agencies.

The Committee recommends that a program be established at the Federal level to support the formation of up to ten State Councils of Educational Technology which would advise State Boards of Education. This number should be distributed among the states to cover different kinds of arrangements, from the situation where a single central coordinating body already exists to a situation where the agency to achieve the desired coordination must be created. Proposals from the states should be solicited so as to develop different models that will allow for the greatest participation and motivation at the state level.

## A NATIONAL OPEN EDUCATION CORPORATION

The concept of "open" education--open to anyone desiring to learn

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* See definition of high and low technology on Page 53.

more for personal enrichment or professional advancement--is taking root in this country. Pioneered in Great Britain, the free access systems now being developed here include the Empire State College, the University Without Walls, the Minnesota Metropolitan State College, the Chicago City Junior College, the Campus Free College, the proposed Wisconsin Open School, a North American Branch of the British Open University, and the State University of Nebraska (SUN).

These are brave new ventures, launched more on intuitive conviction than hard data concerning the actual demand nationally for learning opportunities outside the formal educational system. However, Moses estimated in 1971 that "more than 44 million Americans in a given year participated in educational programs which were conducted outside the traditional institutions and which, at the same time, were overlooked in the official consideration of education activity."[9] A market survey of 1,211 Wisconsin households taken for the proposed Wisconsin Open School showed that 81 per cent of the responders liked the open school concept and 33 per cent said they might enroll in the school's courses.[10] Since its inception in 1969, enrollment in the Open University of Great Britain has grown to about 40,000 part-time undergraduate students in England, Scotland, Wales and Northern Ireland (more than one-third of the first-year students were teachers and recruitment has focused since

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9/Moses, Stanley, The Learning Force: A More Comprehensive Framework for Educational Policy. Syracuse University, October 1971, p. 19.

10/Supplement to the final report of the Governor's Commission on Education, The Open School, January 1971, pp. 19-23.

then on enrollment from disadvantaged groups.)

Rationale For a National Coordinating Mechanism

It is, of course, very difficult to estimate demand for a product that has not been developed or marketed; the open education systems in this country are in much the same position. As a practical matter, their success or failure will hinge on how good a product they do offer--and the development of validated course packages of very high quality is absolutely essential.

Lipson has pointed out "there must be a sufficient number of courses so that a student can obtain a respected Bachelor's Degree in a significant number of high demand and academically sound disciplines. As a rough estimate, I would say on the order of 300 courses would be needed when the project is completed. These 300 should be completed after a five or six year period....then a revision schedule would be started since each course should be revised approximately every 4 to 6 years. In addition there would probably have to be a continual development of new courses as new subject areas become important.

"It seems obvious that this would be too great a task for any one state to take over by itself. Besides, it does not seem appropriate for one state to do the whole job. If different states are working on the same problem of test construction, course development, and the development of systems for student access, it would seem efficient to share the work rather than duplicate each other's efforts."[11]

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11/Lipson, Joseph I., Associate Vice Chancellor for Academic Affairs, University of Illinois at Chicago Circle, in a private communication, April 4, 1973.

Cooperation in course development and related academic matters are not the only problem. There is a need for coordinated planning to insure that various open systems meet common educational standards and common technical standards for hardware as well as software. The systems should be able to avail themselves of common purchasing policies and use common resources (libraries, laboratories, communications and computer networks etc.) as well be able to interact with and utilize existing educational institutions.

Although they may differ in other respects, open education systems share the same basic operating needs. They require a learning resources center for the development, production and organization of course materials for individualized instruction, and a communications/ distribution system, such as television and radio, for the dissemination of lecture courses. The relevance of these two main components in the organizational structure of a comprehensive open education system is shown by the diagram on the following page.

By the nature of their present sponsoring agencies, open systems are restricted to functioning in a single political subdivision, a state, which makes regional development difficult. Therefore it makes sense to create an agency which can operate across state boundaries to establish open systems on a regional and national basis, as dictated by need. This kind of planning can assure the development of open systems able to serve a large enough population to make them viable.

What needs to be avoided is the kind of building-by-accretion program which rarely reaches the level of growth necessary to acheive cost effectiveness and to permit further development. Open systems

OPEN EDUCATION BOARD
Executive Director
Learning Resources Center
Director and staff to represent resources in statewide systems of extension, higher education, vocational and technical education, public instruction, libraries, private and commericial enterprises
THE OPEN SCHOOL
Director and staff for program development, research, evaluation, field work, etc.
Communications Resources Center
Director and staff to represent resources in statewide systems of TV, radio, Educational Telephone Network, film libraries, media centers, commercial broadcasting, private enterprise, wide area services
PROGRAM DEVELOPMENT (Examples)
Open Schoolroom (pre-school)
Drop-In High School
Campus Without Walls
Content (continuing education through new technology)
PROGRAM TEAMS (ad hoc assignments)
Subject Specialists
Learning Specialists
Media Specialists
Field Specialists
DELIVERY SYSTEMS
materials centers - television networks - radio networks - telephone computers - mail - film - audio cassettes - library systems etc.
ACCESS SYSTEMS
home learning centers - business centers - civic centers - schools and institutions - community volunteer services - counselor services - advisory services - experimental locations - new media combinations, etc.

A Comprehensive Open Education System*

*Adapted from the proposed Wisconsin Open School System.

FIGURE 1

should be designed from the start with a level of student aggregation that will insure economic viability.

The Costs and Financing of Open Systems

Open systems have the potential to be relatively inexpensive for both the individual and the community at large, as they are unencumbered with many of the major expenses associated with traditional education. Present institutions of higher education must acquire considerable real estate, construct an extensive campus of classrooms, faculty offices and student dormitories, and gather a large body of permanent faculty. In reaching people where they are, many of these costly elements can be foregone in an open system. By reaching a mass audience through the intensive application of mass technologies, economies of scale can produce a low unit-cost figure which results in saving of a significant magnitude. Theoretically, therefore, open systems appear to make economic sense in meeting the expected demand for education over the coming decades.

The Open University in Great Britain reported per student costs of $900 in 1971 versus average student costs of more than $2,500 a year at a conventional university. However, in this country estimates for student costs in open education systems are almost comparable to some conventional undergraduate programs. For example, Bowen estimates a cost of $1,675 per participant in a high quality external-degree program giving personal attention to its students as compared to undergraduate education costs of as little as $1,200 - $1,800 per student in many

institutions.[12] Higher and not appreciably lower costs can indeed be expected to characterize open systems as long as they are unable to avail themselves of effective technologies that make it possible for them to use a multiplicity of modes with a multiplicity of levels of aggregates of students from simultaneous transmission of lectures to very large number of students, to opportunities for individualized teacher-to-student communication. The key need at this moment is thus to acquire sufficient experience with a number of systems, using a variety of modes of instruction and delivery, so as to determine the most cost-effective configuration.

Initiation of the Open University in Great Britain was facilitated by a government subsidy of $14 million. While this is a sizeable expense, British sources indicate that establishing a conventional university to carry on the same program, with the same number of students, would have cost about $85 million. Projected operating expenses for 1973, when the university is expected to reach the size of 40,000 students, range in the area of $20 million per year.

Information concerning costs of U. S. open systems remains in the form of estimates, for the most part. A recommendation before the Wisconsin State Legislature, for the first full year of Open School operations, requests $380,000 for the two basic components - the Communications Resources Center ($130,000) and the Learning Resources Center ($250,000). Also recommended is a capital outlay of $6.5 million

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12/ Speech by Howard R. Bowen, Chancellor of the Claremont University Center, and chairman of the Financial Committee of the Commission on Non-Traditional Study of the Annual Conference of the American Association for Higher Education, Chicago, March, 1973.

for an updated and extended communications delivery system.[13]

Miller, in a recent study for the Office of Education, provides a cost breakdown of alternative learning centers for use in higher open educational systems.[14] He concludes that approximately $300,000 is required to equip an average learning resources center and makes further recommendations pertinent to the role of the federal government in financing open systems. These include:

- legislation to create a loan program at the $200 million level to provide capital funds to initiate and maintain learning center operations
- an O.E./H.E.W. program at the $40 million level to foster the development of networks linking learning centers to each other and to regional and state production centers
- a hardware development program initiated by the OE at the $3 million level to encourage the design of equipment, specifically for educational applications.[15]

These recommendations lead into the issue of open system financing. Society at large is the co-beneficiary of learning systems that are responsive and relevant to the changing needs of today and the future. Thus, it is not unrealistic or unreasonable to expect society to shoulder a large portion of the operating expenses. This means, of course, that the states should bear the major task of financing open systems. The federal government also should play a catalytic role in subsidizing key activities, including grants-in-aid for the overall development and planning of open systems.

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13/The Open School, p. 28

14/Miller, David, Open Universities in the United States: Four Models and Recommendations, HEW report OS-72-206, October 1972.

15/Open Universities in the United States: Four Models and Recommendations, Ibid.

However, alternative sources of financing should be fully explored by the proposed National Open Education Corporation. For example, employers in business, industry and government could play an even stronger role in financing their employees' education. Income may also be derived from the sale of program materials to other educational institutions or private concerns, or from the royalties received from its use. Development of these sources of funds, plus public support, could be facilitated by the national corporation.

Summary of the Corporation's Roles

In summary, establishment of a national corporation is clearly indicated to encourage and coordinate the overall development of open systems. In this role the corporation would fulfill other important functions:

--Assist the development of standards of compatibility in networking of state and regional resources and communications links so they can be extended nationwide. What is developed in California should become compatible with what is developed in New York, and the systems in those two states (as well as those in between) should be able to communicate with each other. The potential of cable TV, satellites, the new video disc and other technology should be explored.

--Coordinate the development of course materials so as to minimize the duplication of effort by the various open systems. As noted previously, this can result not only in better materials, but the wider use of the materials which in turn will allow a

wider range of courses. Economies achieved by wider use free up more resources and talent for creation of more courses which otherwise might go untaught.

--Develop criteria for effective courseware; carry on pilot courses.

--In cooperation with public and private agencies, collect, analyze, and abstract all open education courses; publish and promote wider usage of such courses.

--Work out processes of local adaptation of courses to specific regions, where cultural, economic, social conditions so require.

--Supply information and expertise to legislative groups throughout the country, and be the informational assistance link to local and regional open schools.

--Initiate research into all aspects of open education.

--Provide a more direct link with industry in design, testing, use and formulation of standards for all educational technologies.

Why an Independent Corporation?

It is clear that to provide the services and execute the roles enumerated above, a national coordinating mechanism for open education must be able to develop policy within a structure that is not as dominated politically as a federal agency.

A corporation chartered by Congress offers a better guarantee of independence. The corporationshould be guided by a national advisory

council composed of representatives drawn from throughout the country. They could include a number of members of state education departments, selected on a regional basis, representatives of professional associations and citizens at large representing user populations.

An important aspect of the corporation that would help reduce political influences is that it would not be an operational agency charged with the running of programs. Rather, it would be largely a policy-making organization designed primarily to develop course materials and coordinate informational, technical, and financial resources for use in state, regional, and national open systems.

The staff of the corporation would be small and be composed chiefly of professional personnel. Most of the work would be contracted to individuals, institutions, industry and other appropriate organizations.

Constituted along these lines, a corporation would be an extremely viable instrument to both originate policy and to marshal support from federal, state and private sources (foundations, associations, industry).

Most importantly, an independent corporation would be able to represent a clearly-defined constituency in coordinating policy and cooperating with the Corporation for Public Broadcasting, the U. S. Office of Education, the National Institute of Education, the Fund for Improvement of Post Secondary Education and other concerned agencies. After formulating its policies, by virtue of its autonomy the corporation also would be able to make an impact on government program and funding

priorities and upon existing institutions in meeting the needs of American education.

It is recommended that Congress establish a study Commission to develop a plan for creating a National Open Education Corporation by 1975 which would report to both the Secretary of Health, Education and Welfare through the Assistant Secretary for Education and to Congress.

## EDUCATIONAL TECHNOLOGY ASSESSMENT

There can be little doubt that educational technology is potentially one of the most revolutionary forces emerging in education today. The current developments are only a timid beginning, but already have challenged established teaching methodologies, established institutional forms for the delivery of education, and established dogmas of the learning process.

To some degree, for instance, the technical feasibility has been shown for both mass teaching and individualized teaching--a much broader spectrum of teaching modes than was thought possible on a large scale even a few years ago.

Educational technology has furthered the prospect of establishing new, open institutional forms that can deliver education more widely and flexibly than the traditional institutions, reaching the part-time learner, the shut-in, the isolated, the disadvantaged, the person whose educational skills and aspirations cannot easily be categorized and standardized.

All the impacts arising from these new challenges and opportunities cannot be expected to remain circumscribed to the educational system alone.

Developments in educational technology are bound to profoundly affect the entire fabric of our society. They are bound to challenge and alter the function and structure of existing educational institutions, they are bound to influence the political goals of vast segments of the society, they are bound to affect the delivery of educational assistance to developing nations. For instance:

- What effects will the ability to dispense instruction and to provide education at home have on the custodial function of many current educational institutions?
- What effect will the inevitably different spectrum of skills that will become needed in an educational system that makes heavier use of technology have on the teaching profession, and on the teachers unions--that is, on a large segment of our working force?
- What aspirations will the possibilities of unbounded, ubiquitous instruction offered by educational networks inject in the political process? What are the implications if citizens demand the right to have access to the "educational utilities" represented by these networks?
- Will labor unions make access to the educational opportunities a part of their demands?
- Will a substantial portion of our foreign assistance programs be carried out through the extension of our educational networks to other countries? What effects will such extensions-- if carried out over two-way channels--have on our own social attitudes and beliefs?

. On a narrower horizon, is it possible to envision the emergence of new technological approaches, or new social attitudes, that would alter the current trends of development of educational technology?

Clearly, there is a need to think systematically about these kinds of questions, if new technological developments in education are not to outpace the ability of our society to adjust to them, and to use them for the achievements of its fundamental goals.

An emerging issue of critical importance in this regard is the allocation of cable television channels. There is a need now to assess the nation's educational requirements for these channels and insure that they are not gobbled up for other purposes. Simply because the most effective educational uses for these channels have not yet been developed should not preclude their availability at a future date. We should not allow present government guidelines and rules to foreclose educational options.

This is but one example of the need to monitor and forecast new technological developments, new social developments as well as new developments in our understanding of the learning process. There is a further need to attempt to assess in advance the mutual impacts of these developments, as well as to look back retrospectively at the impacts of past and current educational practices.

We therefore urge that Congress' new Office of Technology Assessment (OTA) make the monitoring of the impacts of educational technology on societal developments--and vice versa--a standard responsibility. The OTA should be encouraged to provide the nation with in-depth reports and periodic overall assessments of the impacts of educational technology as well as of the probable future direction of the interface between educational technology and society.

## EDUCATIONAL TECHNOLOGY EVALUATION

One of the major limitations in proving the utility of technology in education is the reliability of the evaluation of a particular experiment or demonstration.

There has been an inclination in the past to leave the evaluation to the operators of the experiment. But the operators usually develop such a desire to show success that it is virtually impossible to obtain an unbiased evaluation from them.

It is apparent that a new policy is needed now, on both the state and federal level, to insure that evaluations are made by experts entirely independent from the experimenters. This policy should recognize that for an independent evaluation to be entirely valid it should be designed in concert with the experimental design. Unless both the experimenters and the evaluators are mutually agreed on the criteria by which success will be judged, the experiment is unlikely to answer the questions which prompted its initiation. Further, the funding for the evaluation should also be built-in at the start of a project.

To achieve this objective, we recommend that states and the federal government establish independent educational technology evaluating mechanisms. These mechanisms could take the form of independent commissions or the evaluation task could be assigned existing but separate agencies from those sponsoring the experimental work, such as non-profit research institutes. The evaluator should report to the funding agencies and Congress.

Figure 2

Structure of Proposed Policy-Making and Evaluating Mechanisms

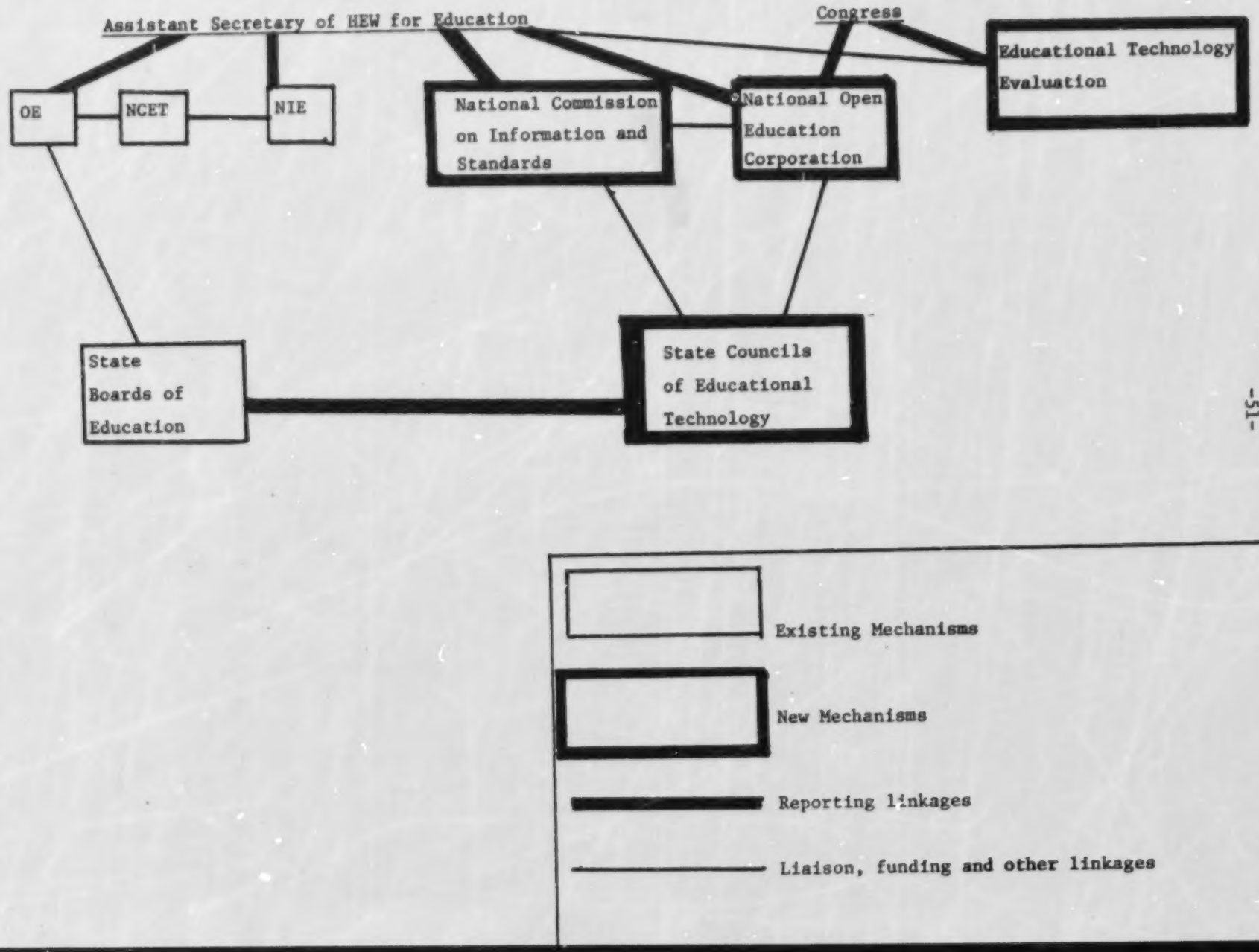
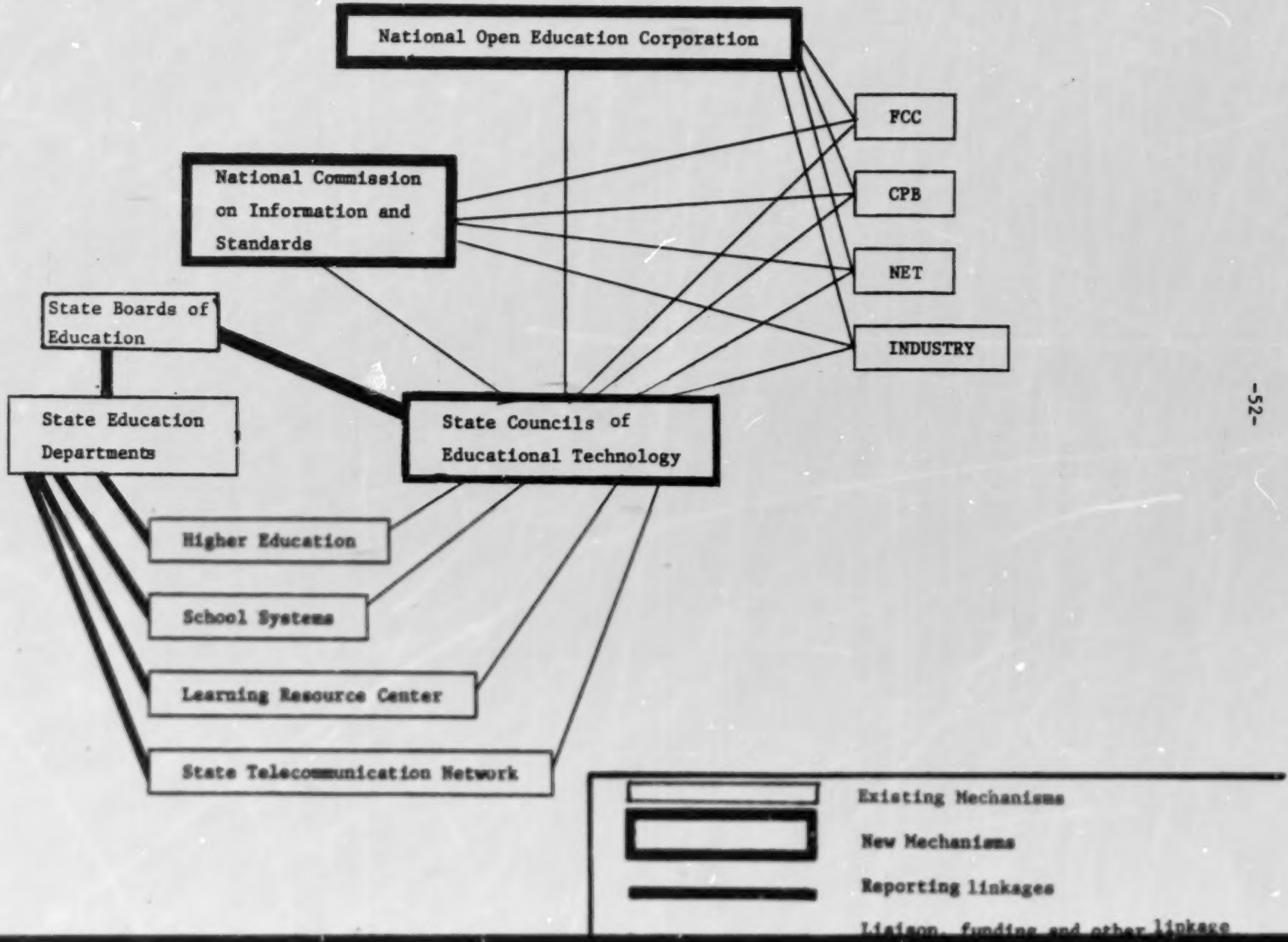


Figure 3

Interrelation of Proposed New Policy Mechanisms



## Chapter III

## TECHNICAL ISSUES AND STRATEGIES

The resolution of public policy and educational issues in the area of instructional technology will depend in large measure upon our ability to solve a number of complex issues of a technical nature.

In delineating these technical issues and needs it is useful to first draw a distinction among the various elements of educational technology on the basis of their degree of complexity. Those elements or products which are long range in nature or require large amounts of equipment and sophisticated software may be classed as falling into the "high technology" category. The remainder may be regarded as "low technology."

An example of the former is the PLATO computer-based instructional system being developed at the University of Illinois at Urbana-Champaign under a National Science Foundation grant. Or it could be a complete instructional system heavily dependent upon technology, such as the proposed "open" schools and universities. The "low technology" category encompasses certain library, slide, film and audio materials that are relatively straightforward to create and place into the hands of the user. They do not require large initial investments, nor are they dependent upon supporting technology such as the leasing of telephone or television channels.

The following summary of major technical issues and needs shows that most involve high technology:

1. Systematic analysis to define the extent and ramifications

of urgent educational problems. Close examination of the requirements of both institutions and learners is needed for the development of better policies and strategies.

2. Establishment of timetables and priorities in bringing to bear technological applications to educational needs.

3. Courseware improvement through the development of consistently high quality learning materials and...

4. Establishment of consumer information and standards to resolve hardware and software compatibility problems and to assure that only validated course materials are disseminated to users.

5. Establishment of a systematic program of educational research and development, starting with basic studies into the learning process.

6. Reexamination of how industry's role may be expanded in the field of educational research and development.

7. Determination of the need for and the characteristics of a national telecommunications network dedicated to the dissemination of educational materials and the support of learning systems.

## SYSTEMATIC ANALYSIS OF EDUCATIONAL PROBLEMS

Technology should be applied to education only when it is perceived through careful analysis that technology has a useful role to play -- not simply in helping to solve an isolated problem, but in improving the total system.

The educational community for the most part has in effect resisted the idea that institutions and the total processes of learning might be improved by careful study of how they work in an operational setting.

The reasons for this resistance are understandable. Terms like operational research and systems analysis often sound to the educator as more appropriate to machines than to such subjectively human functions as learning and teaching. Yet, the concept of bringing systematic analysis to the problems of education--to develop ways of identifying defects in the system and assessing the impact of changes -- certainly is a valid one. Indeed, applying this approach in a manner that will assist the formulation of better policies is probably one of the most profound, albeit less visible, contributions that technology can make to education.

One of the basic problems of the $70 billion-a-year activity known as the educational system is that it is not in fact treated as a system. Education has been broken down into discrete functions, generally by the age of learners, and grouped into subsystems of pre-school, elementary and secondary schooling, higher education, adult and continuation education. Usually little or no consideration is given to the effects a change made in the learning process in one subsystem will have on the next. Thus concepts learned at the elementary level may be totally ignored or repeated in high school. Virtually no allowance is made for what a student learns outside of school. In almost every neighborhood a youngster can be found who has trained himself to be an expert auto mechanic or electronic technician, yet is barely making it through high school.

The subsystems decide more or less arbitrarily what a student must learn at a given grade level, without regard to his aptitudes, abilities and other interests. There is, in brief, an enormous amount of conflict

that might be resolved by systematic analysis of the interaction of the educational components and the individual.

## TIMETABLES AND PRIORITIES

Any systems analysis of educational problems must take into account the timetable for bringing into being technological solutions and the associated cost. The determination of timetables and the establishment of developmental priorities is one of the most important issues confronting educational technology. In a very real sense, because application has been cued to the latest developments for other markets--for instance developments in communications--technology involvement in education has not been governed by a timetable. There has been very little definition of what should be done first to direct technology toward a specific problem in education in an orderly fashion. Furthermore, we are dealing with several different technologies of high and low order of complexity, all susceptible to different developmental approaches for educational purposes.

Although numerous surveys have been made of the current status of various technologies of education, it is imperative that they be extended by the federal government to determine a) their effectiveness in meeting specific educational objectives; b) their cost of operation; c) the feasibility of wider application.

Moreover, the federal government should sponsor studies directed at the future development of these technologies that would a) identify specific bottlenecks such as costs, federal telecommunications policies, the economic/legal issues impinging on dissemination of copyrighted material, etc, and b) assess how the bottlenecks impact upon the future

development of each technology. Accurate forecasts as to the probable rate of advance of these technologies and recommendations as to the timetables for their implementation should be the goal of the studies.

It is important to recognize that elementary and secondary schools alone are now being offered an estimated 250,000 educational media products.[1/] Of this number only 17,000 are textbooks; the remainder are paperback books, audio visual equipment, multi-media kits, films, filmstrips, records, audio cassettes, video tapes and computer-based programs.

Approximately $1.5 billion is being spent by elementary and secondary schools each year on instructional media in addition to textbooks. However, Komoski has observed the great majority of these materials are accepted by schools "without any evidence of the instructional effectiveness being supplied by the producers or required by their purchasers."[2/]

Only California has a law which does require publishers to supply evidence as to the effectiveness of content in relation to specific groups of learners. This law went into effect in September 1972 and no results are available as to its enforcement. However, the fact that one state has recognized the nature of the problem indicates that the issue should be pursued further for all educational technology.[3/]

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1/ The New York Times, January 8, 1973, page C-71

2/ The New York Times, ibid. P. Kenneth Komoski is president of the non-profit Educational Products Information Exchange, which evaluates educational products for about 4,000 schools.

3/ General Learning Corp., McGraw-Hill, Xerox, Science Research Associates (an IBM subsidiary), and Westinghouse Learning now engage in the validation of learning materials for their major programs. Saturday Review, May, 1973, p. 47.

For its part, the federal government also has been lax in evaluating the educational technology it has sponsored. A case in point is the $160 million spent by the Office of Education in support of some 500 computer-based projects since 1965. Assistant Secretary for Education Sidney P. Marland, Jr. has acknowledged that "no coherent body of knowledge...concerning the overall usefulness of computers in education" has resulted.[4/]

The obvious conclusion to be drawn is that we are greatly in need of an information base upon which timetables and priorities can be drawn and identified. Obtaining this information - along with validation of materials - will greatly assist in restoring some semblance of order to the chaotic educational technology marketplace. As matters stand now there are no guideposts by which this technology can be moulded to suit the objectives it is to serve - as has been the case with aviation, where well-defined evolutionary cycles of research, development, test, evaluation and production have brought forth successive generations of better aircraft. It is time for all concerned -- educators, researchers, government officials and industry -- to formulate a more concise idea of where educational technology is headed as a field and how it can be improved. There are several technical issues where guideposts can be developed now. They include:

## COURSEWARE IMPROVEMENT

Fundamental to the application of any new media to education are

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[4/] In a speech to the Education Commission of the States, May 18, 1972.

the quality and content of course materials. To win acceptance in schools and colleges the materials must be of consistently high quality - and until now this has not been the case.

Meaney, for example, sees courseware entering a new and far more complicated period than known up to now. He contends "we have come to the end of a single medium era, the time when educators were willing to concentrate their bets on a favorite runner in the media derby, some on audio tapes, some on film, some on television, some on computers. Now it is becoming clear that these are all winners in their special ways. The best combination of winnings may have to be audio tapes where the auditory sense and economy are primary factors, films where the high definition color picture is the chief requirement, television where you need live pictures or erasable recordings, computers for student feedback or drill, etc. In other words, the multi-media age is upon us."[5/]

The most productive avenue to the design of courseware for individualized instructional development is a system's approach, which should include consideration of:

- Analysis of learners' backgrounds in terms of previous knowledge or skills, educational goals, interests, etc.
- Specification of competencies to be acquired by the learners and development of the means for assessing achievement of these competencies.
- Development of diagnostic entry tests.
- Development of subject content.

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5/John A. Meaney, "The Multi Media Age," To Improve Learning, Vol. II, p. 23, Bowker, N.Y. 1971.

- Specification of teaching-learning activities, including the possiblity of options for individual students.
- Production of appropriate learning resources.
- Pilot testing as a basis for revision.
- Overall evaluation of the new courseware in terms of its acceptability, effects on learning, cost-effectivenes, etc.

This approach implies a shift from an emphasis on teaching to one on learning, and the design of courseware primarily for use by the learner rather than the teacher, and for use by individuals as well as groups.

Attacking the Courseware Bottlenecks

It is important that such courseware development utilize a team approach combining the talents of curriculum specialists, teachers, students, behavioral scientists, media specialists, evaluation and measurement experts, educational administrators as well as industrial manufacturers and publishers. Some of the major efforts in this direction include the development of some prototype systems of instructional software such as the Physical Science Study Committee (PSSC) and Biological Sciences Curriculum Study (BSCS) material and in a number of Computer-Assisted Instruction projects. However, in terms of the total educational need at all levels from pre-school to post-graduate, efforts to date represent only a fraction of what is needed. Furthermore, the cost of developing effective instructional materials is often underestimated, and few schools and colleges have the financial resources to undertake this work on an adequate scale.

In general, the lack of good software has been a bottleneck in the past in many instructional areas, and the development of hardware sometimes is far in advance of the availability of suitable software. On the other hand, improved hardware design could greatly facilitate the production of better courseware. Hardware is a bottleneck where the money or technical development is lacking to make a specific application to education. For instance, many millions of dollars have been spent on the development of computer terminals; yet the PLATO instructional program has been given only relatively small funds to develop a computer terminal specifically for educational use. Such enhanced development of unique hardware could greatly facilitate the efforts of the course development team.

Similarly, video-cassette equipment development has not been carried forward specifically to facilitate the production and editing of educational tapes. Even so minor an example as slide production reveals how educational hardware has been limited by being forced into existing paths. The design of format smaller than 35 mm. would have reduced costs and probably increased production significantly. However, it did not become available until, once again, industry developed the pocket camera for entertainment use.

Financial Incentives

Recognition of the crucial importance of educational software is essential and provision should be made for special incentives to encourage the design and development of validated, effective learning materials. Without adequate financial support for instructional

development, it is unlikely that significant changes will be made in traditional methods of instruction. Such support should not exclude the acquisition or development of appropriate hardware, but it should be justified by the needs of the courses under development and the proposed delivery systems for their implementation.

A diversity of efforts are needed. Modest projects involving the development of courseware for use in a single school system as well as major projects with possible national distribution of the produced materials should be considered and funded.

Furthermore, attention should be given to the development of learning modules which employ a variety of media approaches, including small-scale concepts and mini-course techniques, as well as larger multi-media materials. Specialized course development teams must be organized to develop high-quality educational materials. Special efforts should be made to develop and extend non-print materials which utilize low technology, such as slides, audio tape and single concept film loops, as well as high-technology programs, such as computer-aided instruction and educational television.

The development of educational materials should include the field testing of the materials and comprehensive evaluation involving cognitive and affective criteria and cost-effectiveness determination.

We recommend funds be made available to the National Institute of Education to support the planning and production of course materials for all educational levels. The design of such materials should be based on a systematic approach which would include analyses of learners' backgrounds and needs, specification of desired learner competencies, and

the provision of options to meet the interest and goals of individual students.

## CONSUMER INFORMATION AND STANDARDS

Diffusion of educational technology is being hampered by a lack of consumer information and standards to enable a user to buy systems and components most suitable to his needs, to interface them, to transfer computer programs and to easily operate equipment that is durable, reliable and safe. Part of the problem results from "piggy backing" educational applications onto technology developed for other purposes.

Compatibility of film cartridges is a case in point. Several types of film loop cartridge are on the market, each with its own special projection equipment. Once the user has bought 8 mm. or 16 mm. equipment he is locked into the format and must duplicate or triplicate (in the case of super 8 mm.) his equipment to use other types of cartridges. With video tape there are numerous formats -- all incompatible with each other. A similar problem exists for programs designed for computer-assisted instruction.

The user's irritations and frustrations caused by these difficulties lead to a spectrum of reactions ranging from the belief that only stringent legislation will do, to requests for at least some form of consumer information about the actual and the desirable performance of educational technology systems and components. In the absence of legislation on this matter, or of a reasonable guarantee that his needs will be met, the user frequently abstains from purchasing or maintaining educational technology systems.

On the other hand, the designer of educational technology systems and components fears that stringent standardization measures may stifle innovation, and the management of the companies producing the systems are unwilling to surrender voluntarily the benefits of R & D investments associated with the particular product of their company. Producers may be more influenced by fear of restrictions that may hamper the ability of the marketplace to play its customary role in the development of new products, rather than by a clear knowledge of the extent to which the frustrations and fears of the users of educational technology have inhibited the development of a market.

Another aspect of the problem stems from the fact, as we have seen, that devices and software--but particularly devices -- used for educational purposes are usually designed for the needs and opportunities of the general market, rather than specifically for those of education. Since the educational market for tape recorders, phones, TV sets, etc, is still much smaller than the general market, education has been unable to have its own needs heeded by the designer, producer and distributor of devices and software. One avenue open to education is to consolidate the purchasing policies of the myriad of users of educational technology, so as to achieve greater market leverage.

The problem both for the producers and the users is compounded by a widespread imprecision in terminology, the word standardization being often used when the word standards is meant, and vice versa.

An impasse exists at present, which can be broken only through the decisive and wise intervention, in a catalytic role, of the federal government. There is a need to provide the user with more information

to guide his purchases of educational technology and to restore his confidence, based on reasonable expectations as to the performance of the devices and software. In turn, the producer and the designer need more information as to the effects, on the market, of adhering to some common guidelines concerning the characteristics of educational technology components and systems.

Beyond information, there is also a compelling need to establish mechanisms capable of addressing themselves effectively and impartially to the issue of standards for each component of the spectrum of educational technology software and hardware. The need for such a mechanism has been pointed out by the Commission on Instructional Technology.

A whole spectrum of measures must be considered for attacking the problem of information and standards. These measures will vary for different components of the eduational technology system and for different stages of development and of market acceptance of such components. But they should include:

- Consumer information, including clarification of nomenclature, tests and measurement devices, reporting formats, quality of process (does it do what it claims?).
- Consumer education, to purchase not solely on the basis of lower bid, but also of performance.
- Manufacturer information about consumer needs.
- Establishment of deliberate purchasing policies to achieve meta-purposes, such as the unification of markets or, conversely, encouragement of the diversity necessary for innovation.

- Recommendation of standards.
- Mandatory minimum standards.
- Mandatory comprehensive standards.
- Standardization, in differing degrees.

A number of industrial and professional organizations have been concerned with the issue of standards and information for educational technology. Yet the problem remains acute, primarily because the immediate interests of users, producers and designers differ with respect to the desirability of specific measures. We believe that the issue will not be resolved satisfactorily until an ad hoc mechanism is established. Such a mechanism should be:

(1) Equipped to give weight to -- and be representative of -- the views of all parties involved in the process -- the users, the producers, the distributors, the taxpayers.

(2) Empowered to make recommendations to the users, the producers, and the legislative and executive branches of government.

(3) Provided with autonomy in the performance of its task, both in terms of authority and financial support.

(4) Capable of providing service at the national and local levels through an articulated organization, interfacing with state and other organizations.

(5) Able to avail itself of the expertise of standards-setting organizations, both governmental and private, such as the GAO, the U.S. Bureau of Standards, the American Standards Institute, the International Data Association.

To achieve these objectives, the Committee recommends the establishment of a National Commission on Information and Standards for Educational Technology, to report to the Assistant Secretary for Education. The Commission's membership should be drawn from broad groups of users of educational technology (school systems, institutions of higher education, teachers, students, etc), of producers and distributors of educational technology, of federal, state and local governments, and of taxpayers. It also should give strong representation to appropriate professional societies that have experience in evolving standards.

The Commission should be charged with:

(1) Providing specific recommendations as to the most effective combinations of measures -- from consumer information to standardization to uniform purchasing policies -- that will facilitate the diffusion of specific educational technology systems and components, taking into account the proper interests of the users, producers and distributors, but guided by the imperative of maximizing, for the learner and the taxpayer, the effectiveness of expenditures for educational technology.

(2) Undertaking in-house studies of performance of educational technology systems and components.

(3) Undertaking, when necessary, either in-house or through contracts, developments aimed at removing bottlenecks in portability and interchangeability, and at setting standards for the performance or cost of educational technology systems and components.

(4) Undertaking a broad program of users and producers information, through courses, seminars, publications and any other necessary means.

(5) Working in close liaison with the National Center for Educational Technology and the proposed National Open Education Corporation.

The Commission should be provided with the budget and staff necessary to carry out its mission, and should be mandated to utilize as much as possible the expertise of other federal organizations, such as the Bureau of Standards, or the General Accounting Office.

## THE PROBLEMS OF R & D

One of the greatest barriers to improvement in the educational system is a lack of knowledge about the individual learning process. We simply do not know enough in many instances how to design new types of learning systems and to implement them. It is necessary therefore to begin now to institute systematic programs of educational research and development. The need for such programs already has been recognized and is exemplified in a study sponsored by the Carnegie Commission to identify specific areas in which to concentrate research efforts.[6/]

It should be noted that currently spending on educational research and development is miniscule. Levien reported, "even now educational R & D receives only slightly more than $200 million annually and occupies the talents of fewer than 10,000 R & D personnel. This is tiny when compared to the size of the educational enterprise, which contributes over $70 billion to the GNP, employs over 3 million personnel, and engages about 60 million students. The investment in R & D is only 0.3 percent of operational expenditures in education."[7/]

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6/ The study was performed by the Rand Corp. and scheduled for publication later in 1973.

7/ Roger E. Levien, National Institute of Education: Preliminary Plan for the Proposed Institute, a report prepared for the Department of Health, Education and Welfare by the Rand Corp., 1971, p. 5.

The issue of how much should be spent on educational R&D has been raised by others. The Commission on Instructional Technology recommended a budget for the National Institute of Education that included $250 million for R&D, $25 million for organizing a national "library" center of educational resources, $100 million for demonstration projects, and $40 million for the training or retraining of teachers, administrators and specialists in the use of new instructional techniques. The Carnegie Commission on Higher Education recommended immediate federal expenditures of $100 million for research, development and utilization of new media in higher learning. The Commission said this outlay should be increased annually until it reaches a sum equal to 1 percent of the total national expenditures on higher education.[8/]

Both these proposals merit more scrutiny by Congress and the Executive Branch of the government. A legitimate question exists as to whether as a result of present low level of educational R&D, the nation is penalizing itself. It would appear far more effective at this time to develop an R&D spending strategy that is geared to the needs of a systematic research program, rather than to limit such a program by arbitrary budgetary ceilings. The amounts involved are simply not that great when compared to R&D spending on health, defense, and space exploration.

Convincing Demonstrations

As noted earlier a major barrier to the development of effective

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8/ The Fourth Revolution, Instructional Technology in Higher Education, op. cit.

educational technology systems is that these systems have not been well tested in both the educational and economic sense. There is a need to stage demonstrations of sufficient scope so that rational public policies may be developed for the large-scale operational use of technology.

An important experiment which should be conducted in this respect is the testing of more flexible institutional arrangements for the delivery of instruction through differentiated staffing. We can envision an experiment employing master teachers, senior teachers, classroom teachers and paraprofessionals. All would be given extensive training in the strengths and weaknesses of alternative instructional media. They would then be allowed to select whatever instructional methods they wished -- along with the courseware at reasonable prices -- and proceed to teach an entire elementary school for a sufficiently long period of time to test the system throughly. Such an experiment would cost several million dollars. But if properly designed, it would produce the information and experience which is indispensible to making decisions for larger-scale systems.

Helping the Disadvantaged

A basic research program also should be designed around the known and suspected reasons why individuals from economically and culturally deprived backgrounds experience learning difficulties. These studies should examine a broad range of issues, from nutritional deficiencies as they relate to learning aptitude to linguistic deficiencies, to the environmental factors which motivate and/or discourage learners.

The information developed in this program should then be used to

design educational materials which can be incorporated into systems to assist the disadvantaged in overcoming their learning handicaps.

Equipment Development

Previous sections have enumerated various criteria to improve courseware. There is a concurrent requirement to facilitate the educational process through the development of better hardware. The needs and opportunities are many. For instance:

- A rugged low-cost (less than $500) visual display unit capable of accepting analog and digital alpha-numeric signals. The unit should be able to display motion as well as line curves and graphs. Small screen display hardware for small group viewing can achieve substantial savings in first-cost, materials use and storage.
- Similar opportunities are available to save cost of reproduction and storage of printed materials if the microfiche format is fully utilized through the design of low-cost portable readers.
- A major shortcoming in the educational application of audio tape cassettes is the lack of quick random access to predetermined selections on a given tape.
- Closed loop motion picture hardware should be developed further to achieve substantially increased reliability and much longer life. Video casettes may provide a reliable, long-life source of moving images, but they are still new to the market and their ruggedness is suspect.

- Color reproduction of printed material at low cost (1¢ per page) in small quantities would assist the development of lost-cost cassette tape/workbook formats. This format has the advantage of allowing a student a wide latitude as to the place of study and can relieve a school of a substantial portion of the capital costs required for converting the instructional program to extensive individualization.
- A major deterrent to the development of industrial markets in movies, audio and video tape is the growing practice in many educational institutions of pirating materials by copying onto audio and video tape. Legal actions may be the principal way to cope with this problem, but technological solutions should also be fully explored. A successful technical approach would probably be more effective and less costly.

For most of the above examples the basic technology is available, and only development is required. However, to achieve the full impact of these and other desirable developments, basic research will be needed into the way individuals learn.

Basic Research

Basic research should be pursued in those frontier areas in the natural and social sciences and in engineering which hold the promise of contribution to education. These include studies in genetics which relate to inherited diseases that interfere with learning; studies of protein synthesis which relate to the way that memories and learned

skills are stored and used; neurological and brain studies of the way that various levels of information are stored and the interaction between various kinds of experience and academic learning (e.g., there is suggestive evidence that vicarious experience plays a major role in the idiosyncratic way that each of us approaches potential educational opportunities. What are the ways that the rapid technologically induced shifts in the environment affect our learning patterns?); studies of the way that patterns of reinforcement in natural social settings bias an individual's learning; the chemical basis of signal transmission and storage; the way in which abstract concepts (e.g., in mathematics) are built up to a level of flexible use and the way that we use these abstract concepts in creative, problem-solving ways; studies in the basic physical and information sciences which offer great promise of more powerful systems of educational technology (e.g., which may provide natural computer languages, more effective information retrieval systems, greater memories with rapid access).

Since basic or fundamental research by definition has an uncertain payoff, the support should be limited in amount and carefully allocated to individuals in the disciplines who are oriented toward educational payoffs. Nevertheless, the history of research suggests that basic and fundamental studies in important areas which underlie a field are critical.

Still another form of basic research which is often overlooked is in the methodology of research in natural social settings. Unless we can extract knowledge and evidence from the flow of behavior and change in society, education will not develop the cumulative character

which has made other sciences capable of systematic engineering applications. We need more powerful methods and strategies for observing human events and ways of planning social and educational experiments to create an adequate knowledge base for designing educational systems.

The Committee therefore recommends that the National Institute of Education establish a long-range and broadly conceived program of basic research in those aspects of the social and natural sciences and of engineering which promise major innovations in educational technology.

## INDUSTRY'S ROLE IN R&D

In seeking to strengthen educational research and development, it is obvious the government must reassess the role to be played by the instructional materials industry. This industry represents an important resource of talent and market experience that presently is being by-passed in the development of innovative materials under federally sponsored research.

During the past 15 years, the federal government -- chiefly the Office of Education and the National Science Foundation -- has channeled funds mainly to academic and non-profit research groups to provide leadership in curriculum reforms for schools and colleges. The basic rationale underlying this policy is that the development of materials for innovative programs such as IPI Math, Harvard Project Physics, computer-assisted instruction and others involves investment risks that the private sector is unwilling or financially unable to take. Because the private sector did not put its money into basic research, it was decided that industry would be excluded from development of the materials.

It was also decided that since taxpayers supported the basic research and development, materials that did become available should be in the public domain. Government policy-makers apparently believed the materials would receive wider dissemination this way. However, this did not happen and the policy was amended to permit five-year copyrights by publishers. That change in policy has brought about wider distribution in many cases where the materials were such that

publishers could make a profit.

Clearly, the present arrangement is far from satisfactory. There is no guarantee that any given set of materials created by an educational institution, no matter how well validated, will be disseminated. Reproduction costs, for example, may be so high that no publisher will seek a copyright and attempt to market them. Or there may not be a large enough market to warrant publication.

It would seem apparent that it is necessary to place the ultimate distribution of a product on a par with the research when a new materials program is launched. If industry is to be the marketer, then it makes sense to bring industry into the research and development phase. But accomplishing this poses many difficulties that are rooted in the highly competitive nature of the instructional materials industry.

New policies and mechanisms are needed so that industry can participate without making one or two companies dominant and suppressing their competitors. If it is granted that academic institutions are best suited to do the research, and industry is best at product development and marketing, we should reexamine contractual policies to permit such mechanisms as consortia and joint ventures. This might permit a group of companies to work with a university curriculum development center. Or we might think in terms of individual companies, selected on the basis of competitive bidding, becoming systems managers for instructional program research and development. As prime contractors, companies could subcontract out research to academic

institutions. The Government might be able to recover its costs through royalties after the contractor markets the product.

These are potential short-range methods for involving industry. For the longer term, if the application of technology does become more widespread and orderly, then it may well be possible for industry to pay its own way in terms of applied research and development. There will be more definite markets to cater to. This also applies to the developers of equipment for the educational market. As noted earlier, the technology is available to build a low-cost compact visual display unit to accept audio and alpha-numeric signals. But it is unlikely that any company will undertake the research and development of such a unit until there is some verification that a market for it exists.

A developing role of industry is the actual delivery of instruction under performance contracts, in which payment is geared to student achievement, and under other contractual arrangements. This activity could be enhanced by more research. It is also a distribution mechanism for materials as well as for feedback into materials R&D that can not be ignored.

Thus, in reassessing its policies the Government should consider the catalytic effect it can have in making educational research and development to some degree self-sustaining.

The Committee recommends, therefore, a re-examination of policies to permit private, profit-making companies to be employed as prime contractors, either alone or in consortia with academic institutions and government agencies, in programs to develop innovative instructional materials and methods.

## NATIONAL NETWORKS FOR EDUCATION

A thorny issue which needs to be attacked soon concerns whether the nation will require a telecommunications network dedicated to education and, if so, how such a network should be constructed.

The first part of this issue revolves around the question of access -- what services could be provided more efficiently by such a network to more people?

Earlier in this study the problem of opening up the educational system was explored and the recommendation was made that more access and diversity could be obtained by interconnecting, or networking, the various parts of the system. In addition to providing wider variety and higher-quality learning materials, networking also can allow access to more data banks and information resources.

While it is possible to perceive how an economics student in Arizona might benefit materially from having electronic access to, say, a computer in Chicago containing statistics on the Gross National Product, there is a very difficult problem relating to the cost of such a service. Would it be more economical for him to depend upon the Postal Service for a printout of the data? Or we might consider the student in Minnesota who would like to talk to a teacher in a Nebraska open university. Should he be connected to the teacher or try to obtain the information some other way? Or to take another illustration, assume that several states adopt PLATO-type computer-assisted instructional methods. Should each state have a computer

or would there be an advantage in interconnecting several states to one very large computer?

It is obvious that the economic advantages and disadvantages of networking strictly for educational purposes demand considerable study. The National Institute of Education and the proposed National Open Education Corporation should consider this issue in the light of existing local and state distribution systems (Table I).

What must certainly be taken into account at the onset is that any network must continue to meet and, if possible, improve the servicing of local needs. As a design parameter for a national system, this stipulation creates a serious complication because the educational needs of communities across the land are extremely diverse. Moreover, to be really effective, educational materials delivered by television and radio have to be planned for specific target audiences and supplemented by a variety of other services. Is it possible to service all these needs without winding up with a system that is not altogether too cumbersome and unmanageable?

The methodology of telecommunications networking is another very important element, also requiring a great amount of study. A key technical issue concerns the need for delivery of both alpha numeric and television image reproduction signals.

Under the present state of the art, audio signals and television image signals can best be transmitted by analog circuits. On the other hand, digital transmission techniques are more efficient in using the frequency spectrum and they provide higher levels of transmission accuracy and reliability. Alpha numeric information can be sent by

TABLE I*

POTENTIALLY USEFUL AND EXISTING
LOCAL & STATE DISTRIBUTION SYSTEMS

| | Number of Systems/ Stations/Nodes |
|---|---|
| Cable Systems<br>Individually owned systems<br>(52 multiple system operators. The National Cable Television Association estimates that MSO's include at least 2,000 systems reaching 75% of all potential subscribers)<br>Source: NCTA Officials | 2,800 systems |
| Instructional Television Fixed Service (ITFS)<br>ITFS stations operate on 28 channels in the 2500-2690 megahertz frequency range. Each station can be licensed to operate no more than four (4) channels. The 164 stations with licenses (93) or construction permits (71) operate approximately 540 channels.<br>Source: FCC Data | 164 stations |
| VHF - Commercial Stations<br>Noncommercial stations<br>Source: FCC Records - January 20, 1972 | 511 stations<br>89 stations |
| UHF - Commercial<br>Noncommercial stations<br>Source: FCC - June 30, 1972 | 190 stations<br>125 stations |
| AM - Commercial<br>Noncommercial<br>Source: CPB Office of Radio Activities June 30, 1972 - FCC | 4,367 stations<br>28 stations |
| FM - Commercial<br>Noncommercial<br>Source: FCC - June 30, 1972 | 2,352 stations<br>532 stations |
| NOTE: Class D (10 Watts) Radio Stations in High Schools, etc. | 264 stations. |

* From a paper, "Recommendations for a National Educational Telecommunications Network" contributed by John A. Curtis, to the Advisory Committee on Issues in Educational Technology, Commission on Education, National Academy of Engineering, October, 1972.

digital circuitry with less cost than by analog circuitry. Therefore the advantages of establishing a digital network for education should be considered. The issue has direct bearing, for instance, on the important problem of how computers--which are digital devices--are going to be interconnected in the educational system.

Present communication between computers is commonly accomplished by converting digital signals of one machine to analog signals that are suitable for transmission and then reconverting them back to digital for the receiving machine. This creates conversion and other telecommunication difficulties. Digital technology appears to have substantial advantages in any extensive computer service educational network: the equipment is more economic to build and install than present frequency multiplexing systems.

Assuming that a substantial development of a telecommunications network occurs for educational purposes, the question of access capability becomes an important one. This involves the points where educational institutions and systems can have access to the network and the compatibility requirements for making such an access possible. Clearly such an educational network must be a switch system so that the user entering the network at any entry point can send to or receive information from a user served by any other entry point facility.

For example, in making available to Connecticut a computer-assisted instruction system developed and operating in New York, the question arises whether it is cheaper for the system to be developed independently in Connecticut or to be developed simply by establishing

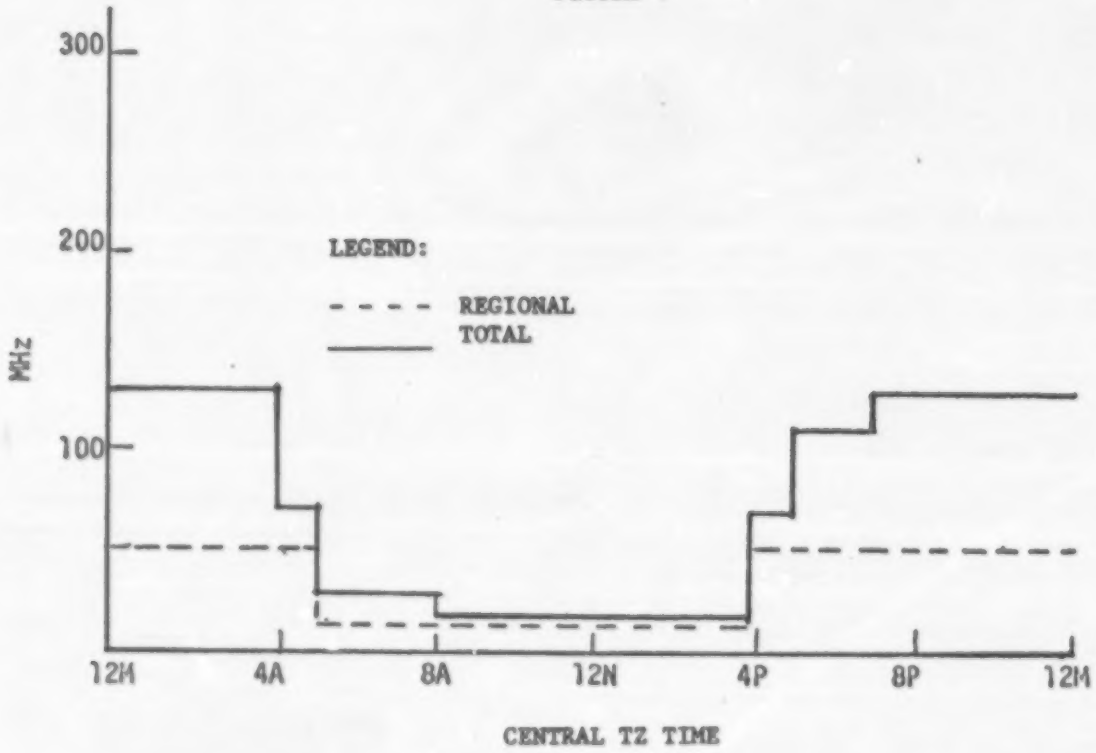
communication lines with the New York system. The National Open Education Corporation we have proposed, would be an appropriate mechanism to deal with the technical issues as to how to perfect this interconnection. It is very conceivable that every state and a large number of educational institutions in every state may eventually need to have access to computer-assisted instruction. They also may need access to computers for management and other functions. If so, the question of the communications link that would make this interconnection possible becomes an important one.

Some of the technical issues that need to be analyzed include the number and location of computers, the location of the control points, and the nature of the links--whether they have to be audio or digital considering the fact that there are great advantages to a digital link for computers and that the digital link is best carried by microwaves.

Another part of this issue is the extent to which educational networks can utilize networks developed for other purposes. An example is the proposed electronic mail network. Figure 4 indicates how from approximately 4 a.m. to 4 p.m., the system, as envisioned by the U. S. Postal Service, will experience a lull in the data transmission rate necessary for postal service purposes. Therefore, there is a considerable amount of capacity available for other purposes.

The question with this and other systems is a twofold one: Can the excess capacity in non-peak periods be utilized by educational institutions? And, more generally, can additional capacity be added economically to the system to serve educational purposes?

FIGURE 4 *




The tentative time loading distribution of Electronic Mail Handling Centers taking all factors into account.

*From a paper, "Electronic Mail Handling" by Donald G. Haag, Manager, Advanced Systems Concept Development Research Department, U.S. Postal Service, contributed to the Advisory Committee on Issues in Educational Technology, Commission on Education, National Academy of Engineering, November, 1972.

Concurrently, it is imperative that the educational system plan for the effective utilization of such a capacity, and make a convincing case for education's claim on such a capacity.

To summarize, from the technical viewpoint there is a need to:

-Identify and analyze foreseeable telecommunication technologies which may be economically and practically used in achieving the goals of a National Open Education Corporation. This should become a specific task of the technical staff of the Corporation.

-Outline the steps necessary to eliminate existing technological bottlenecks.

-Define those distribution services which should be supplied by local and/or state government bodies, and those which should be made available by the federal government.

-Develop and provide in-depth descriptions of the engineering methodology, the installation plans, the operation or organizational requirements, including the associated capital and operating budget factors which are essential to the timely establishment and continuing operation of communication linkages for a national system of open education.

-Develop on a state by state basis an engineering installation and operational plan to provide the comprehensive distribution of educational materials and services.

-Carefully study and evaluate all existing and immediate foreseeable knowledge banks, computer facilities, and distribution systems and networks, so as to minimize duplication and to eliminate unnecessary implementation costs.

-Finally, consult with all pertinent federal and state authorities as well as local government bodies to ascertain educational needs as these groups see them, and determine what non-educational as well as educational telecommunication needs might be served by a national educational telecommunication network.

## Chapter IV

## EDUCATIONAL ISSUES AND STRATEGIES

The existence of technologies to extend the horizons of man and to communicate knowledge more freely poses a number of controversial issues for education and society as a whole. The ingredients are at hand to literally remake the educational system - to alter its structure and change the method and style of delivering learning from preschool to higher education. But whether such overall changes will indeed be attempted is an open question. Today, technology in any context is an alarming word for many people who believe man is really no longer in control of the total man-made environment he has created. When applied to education, the concept of technology is even more emotionally freighted for those who frankly fear it will dehumanize the learning process.

Silberman has noted that in employing technology to increase the productivity of education the "less tangible objectives - learning how to learn, to accept change, to be flexible, to be sensitive to the needs of others, to understand the problems of people one has not met, to work well with others, to accept people who are very different from oneself, to appreciate beauty, to accept leisure without guilt, to put together life experiences in an integrated way, and to be self-directing - could be ignored unless the technology is developed by people with broad vision."[1]

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1/ Silberman, Harry F., "Some Reservations About the Application of Technology to Increase Productivity in Education" from Application of Technology To Improve Productivity in the Service Sector of the National Economy, National Academy of Engineering, 1973. p.47

These are very legitimate concerns for which technology needs to supply the answers. In attempting to communicate and to teach subjective human values, it must be acknowledged that television, radio, film, and perhaps to a lesser extent, printed materials, have inherent disadvantages. They are one-way forms of instruction; that is, the receiver cannot talk back, interract and question the instructor's attitudes, prejudices and opinions. This drawback may be overcome by two-way cable TV or telephone systems, if economically feasible.

The instructional media do have the capability of providing a far wider range of information, more vividly and more interestingly, than most classroom instructors. It might well be, for example, that this media informational function never could teach a person to wholly accept someone very different from oneself because a condition of that acceptance usually is a personal contact. But prior information could provide the basis for acceptance once the personal contact has been made. It is human nature not to take someone's word for something, but to discover for oneself.

Therefore technology must be viewed as playing a complementary role in education. Within its limitations it is perhaps the only alternative available to attack certain deficiencies and difficult problems. But there are deep philosophical problems which cannot be ignored when we examine the three main educational issues raised by the potential application of technology:

1. Whether the introduction of technology can make the entire system more productive and meaningful in both an economic and learning output sense.

2. Whether the introduction of technology will increase the opportunity for everyone in our society to have the same quality of educational experience - and whether it can be of particular help to the disadvantaged.

3. Whether it is possible to modify the attitudes of teachers and learners, as well as those of the rest of society, to accept educational technology and the changes its introduction implies.

## INCREASING PRODUCTIVITY

The inflationary state of the national economy has sharpened the issue of educational productivity until it is now a primary concern. Costs have risen steeply in the past decade - from $27 billion in 1960-61 to operate public and private schools from kindergarten through college, to $70 billion in 1970-71. This was an increase of 160 per cent, while student enrollments went up only 29 per cent in the same period.

Ever larger outlays for education have met with taxpayer resistance; state and federal officials are trying to apply the brakes. One response has been an attempt, or at least a call by educational authorities, to make the system more "productive." Productivity is generally used to connote cost effectiveness, but the word of course has much broader implications, particularly when related to the problem of inequality of education.

On one hand, attacking educational inadequacy clearly implies spending more money to provide better learning resources. On the other, it can be argued that to make the educational system more productive -- in the sense that improved education will make more people and the nation better off financially -- also warrants a larger investment. But both of these propositions are long-term in nature and difficult to quantify.*

The immediate reality is that taxpayers want more for their money now -- in the form of higher quality and more diverse education to suit individual needs, including those of the disadvantaged. But if costs keep rising, there is more likely to be a diminution in quality and a rollback in what up to now have been considered essential educational services.

Clearly, alternatives are needed to help resolve these issues - and the primary question is, what alternatives can technology provide?

## Measuring Productivity

The accepted concept for measuring productivity is to set forth the relationship between the volume of output and the effort required to produce it. Changes in the ratio of these elements over stated time

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* We clearly reject the proposition that productivity can be increased, as indeed it can be in a narrow sense, by eliminating on the basis of cost consideration alone, those components of the educational process which are more costly because they cater to the disadvantaged or to other groups or problems which require special effort.

periods become measures of productivity efficiency. However, in a service activity like education where the output is human learning and training, productivity is extremely difficult to measure.

Schultz[2/] has developed the concept of "human capital" as an expression of educational productivity. In this concept the growth in worker productivity is mainly a consequence of acquiring additional skills from education and training. The acquisition of these skills, he notes, "is in essence an investment in human capital and its contribution to output depends upon the amount of the investment and upon the realized rate of return." He has translated the rate of return as the ability of individuals to attain additional future earnings. Based on the after-tax income of white males from 1939-61, he concludes that "schooling and education are in general a good investment; the rates of return are as high and for the most part higher than the implicit 10 to 15 per cent rate of return....for the private domestic economy on nonhuman capital."

Schultz' study reinforces the concept that the educational system serves a large part of the population adequately at reasonable cost even though much of that cost must be assumed to include the support of inadequate schooling for substantial segments of the population who subsequently become unemployed or unemployable. However, it should be noted that the study does not include the 160 percent increase in educational costs experienced in the 1960 decade. Thus, while the concept

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2/ Schultz, Theodore W., Education and Productivity, a paper prepared for the National Commission on Productivity, June, 1971.

for measuring productivity as a factor of human capital may be valid, the actual ratios indicating productivity may be far lower today.

Schultz' measure of productivity deserves further study and development for it impinges on the primary cost factor in education - teaching - and the viability of technological alternatives.

Substituting Technology

Approximately 75 percent of the costs of the educational system are allocated to teacher salaries. In such a labor-intensive activity, it is reasonable to assume that there is considerable potential for cost reduction with capital substitution through technology. This potential is buttressed by today's situation - a leveling off of demand (enrollments) in almost all grades, resulting in a growing leveling off of teachers.

A further consideration in substituting technology, as noted in Chapter II, is the evidence that there is no significant difference in the achievement of students taught through educational media as opposed to the traditional classroom teacher. If true, this means that the single basis for deciding upon some instructional strategies can be cost.

Two of the most obvious ways of paring instructional costs are to use television for lecture courses (in colleges and to some extent

in secondary schools) and computer-assisted instruction for drill-skill tasks. Hayman and Levin[3/] have produced cost figures which indicate that even with only a few cooperating institutions television could reduce lecture costs by up to one-third and at the same time significantly improve the quality of presentation. On the basis of their figures, for example, the respective costs for college level intermediate and large lecture classes conducted by a professor are $3.00 and $0.75 per student contact hour. The same costs using television would be from $1.50 to $2.00 for the intermediate-size class and from $0.30 to $0.60 for the large lecture classes. An estimated 50 percent cost savings may be possible for an intermediate-size biology lecture class where there are 30 cooperating junior colleges in the television production.

Again referring to the Hayman-Levin figures computer-assisted reading and mathematics instruction for elementary pupils in compensatory educational programs could save as much as $2.00 per pupil contact hour, or approximately one-third. The saving is obtained by permitting the course specialist to handle more pupils.

It should be noted that the television lectures do not eliminate the traditional instructor. The assumption is that television will allow the instructor to devote one-third as much classroom time per course as in the conventional course.

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3/ Hayman, R. W., and Levin, Herman, "Economic Analysis and Historical Summary of Educational Technology Cost," Appendix III of Efficiency and Productivity in Education, Federal Council for Science and Technology Panel on Productivity in Education, Washington, D.C., forthcoming.

These examples indicate how technology can be used in existing institutions to reduce the number of instructors and thereby cut costs, if that is the sole objective. However, it is doubtful whether this will work in practice, because of resistance by teachers and students to automating at the expense of jobs. And, in fact, we do not envision straight cost reduction as the primary role of technology in making education more productive, at least for some time to come, for this ignores the primary element - quality.

Rather, technology in existing institutions should be used to free up the teacher's time for more important tasks, such as being able to devote more attention to learning problems of individual students. Experiments should be developed in this vein with the cooperation and approval of teachers' unions to determine how they can spend their school hours more effectively.

Clearly the introduction of technology in this context will mean an additional instructional cost. But the cost increment could be comparatively small when weighed against the corresponding gain in the quality and diversity in schooling in attacking the problem of pupil retention; and in preparing students to lead more meaningful lives.

Moreover, applying technology to the drill-skill tasks allows greater freedom in revising the structure of instructional systems, such as differentiated staffing headed by a master teacher and employing less classroom teachers and more paraprofessionals. Again, such re-structuring should be attempted only with the full cooperation of the teachers' unions. While these schemes may appear to be a threat to

teacher security, with actual experience they may find that threat to be overstated.

Under scenarios for differentiated staffing, for example, Kiesling[4/] found that the number of required accredited teachers could be reduced by 5 to 27 percent. But at the same time total wages would rise by 8 to 12 percent. The increase would be reflected in substantial salary boosts for teachers because they would have to become skilled in the management of technology-based instruction. (Traditionally, the introduction of more sophisticated technology in industry has been accompanied by higher wages because it demands higher skill levels.)

There is a need now to develop plans that will test the hypothesis that technology can build more flexibility into the existing educational system. We recommend the federal government provide the testing opportunity by sponsoring demonstrations in selected elementary and secondary schools and colleges.

Opportunity also should be provided for the testing of more extensive technology in school districts that are being formed for "new towns" and other new communities in formats similar to that planned for open universities.

In summary, technology has the potential of making education more productive for "human capital" from the standpoint of increasing the flexibility and the quality of learning in existing institutions for the

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4/ Kiesling, H. J., "Staffing Patterns and Costs in Alternative Educational Futures," Directorate for Scientific Affairs, Organization for Economic Cooperation and Development, Paris, 1973.

same or minimal increases in cost. Although technology could cause employment to fall somewhat - a reduction easily absorbed through attrition - teachers' wages would rise.

## TEACHER/LEARNER ACCEPTANCE OF TECHNOLOGY

Quality and relevance of course materials bear heavily upon whether teachers and learners will accept technology. But these are not necessarily the most important conditions. What appears to be more critical are attitudes with respect to the environment where the teaching-learning process takes place, and what is brought into it through technology.

Teachers and learners are confronted by a disturbing problem of exercising responsibility of choice at a quality level. Making the proper choice is part of the philosophical debate over accepting the options offered by technology.

Why doesn't the school learning environment admit more technology and use it? A teacher decides to use or not to use technology according to his or her perception of how technology affects the concept of self as teacher. What questions go through the minds of teachers faced with the choices respecting the use of technology? They often seem to be: What will happen to my role as teacher if technology brings in an environment not fully under my control? What will happen to my students' role and development when more options and choices are made accessible to them? What will happen to our relationship? Will I like or dislike that changed relationship and environment? Will I like or dislike the

new activities that will necessarily replace some of the things I do now? Will I have to be trained or retrained to use the new technology? Do I want to be? Do I believe that the extra effort and trauma of change will make me a better teacher, and help my students learn more? Will it make my work easier or harder? What credit will I get for using technology? If the technology really works, will I be working myself out of a job? I know where my career line is now; where is the career line that strengthens pay and security for innovation and adoption of technology? If I am going to use technology, how do I check it out first, so I know it fits my and my students' needs? And if I want to use technology, how do I bring it in under my control? How do I have something to say about the content and quality of what comes in? How do I know what technology actually does to people under my charge? Who will pay for the technology - how can I get what I want and need without a hassle with administration, school board and taxpayer?

The range of questions runs the gamut from the self-serving to the professional. It is too easy to blame teachers for failing to make use of the benefits of technology in teaching, denying thereby to students the benefits of technology in learning. The teachers' questions are relevant; and for the most part there have been few convincing answers, especially from the producers of the technology, whose concern has been primarily with profit.

There is likely to be a positive swing towards technology in teaching and learning - towards a teaching and learning environment served by technology - only when the answers to these questions (many of them

philosophical, since they relate to values) are more satisfactory than they have been in the past, and when government, school administrators and professional organizations undertake the serious and much neglected task of setting educational priorities on the basis of values to individual learners and society. If the American teacher and the American learning public (practically all of us) make a value decision that technology improves opportunities for learning, enriches the profession of teaching, and strengthens our society because of the quality and diversity of its human products, then the other problems that beset educational technology will also be solved, for they, too, stem from an uncertain and immature philosophical base.

Dealing With Resistance to Innovation

Strategies designed to persuade more people to make informed value judgments toward technology must take into account human behavioral patterns that show deep-seated resistance to change. From a sociological point of view, Etzioni has documented how little advertising, exhortation, and information campaigns have been able to modify human tendencies. Behavior patterns from cigarette smoking to the use of seat belts are remarkably resistant to modification by indoctrination or education. Doctors, who surely should know better, have a severe incidence of drug problems. What is more, Etzioni shows that advertising and information campaigns are not cost effective as compared with treatments based upon technology or pharmacological approaches.

5/ Etzioni, Amitai, "Human Beings Are Not Very Easy to Change After All," Saturday Review, June 3, 1972, p. 45.

It is not at all clear that we have even an elementary understanding of the rules which may determine what we like or dislike, what we choose to buy, what we choose to do with our lives, what we choose to resist. The words which we align to describe and explain may screen and confuse rather than clarify - so rudimentary is our knowledge. We have a range of psychological theories ranging from Maslow's hierarchy of need to Operant Conditioning, yet even the theorists agree that the explanation of complex behavior such as is classified under attitudes or motivation is not in a satisfactory state.

Thus, we recognize resistance to innovation as a serious matter in education. We also realize that we must deal with this as best we can through a variety of mechanisms established by tradition and experience. Yet we must not expect too much. Some components of resistance may be embedded deep within the roots of human behavior; superficial attempts at explanation and treatment will probably not get us too far. We can make progress, without the disenchantment which comes from not expecting more than we can achieve, only if we face up to the difficulty and work hard with the tools we have.

Debating Change

One tool that might be put to effective use is the stimulation of public debate on the issues pertaining to the acceptance of technology in education. It would be a proper subject for academic, professional and public interest groups to stage public television and radio confrontations on the pros and cons of bringing about technological innovation. The proposed National Open Education Corporation itself

would be a good subject to inaugurate the debates. It is highly probable that few Americans are well informed as to the advantages and limitations of applying technology to learning; the informational function alone of staging debates would be worth the effort.

## EDUCATIONAL EQUALITY AND OPPORTUNITY

One of the great unfinished tasks of American society is to broaden the opportunity for everyone to obtain the training and knowledge they need to realize their personal goals and ambitions.

Considerable progress has been made in this direction in recent years. Today there are more opportunities--mainly through the creation of hundreds of low-tuition community and junior colleges--for more people to avail themselves of a better education than ever before. But inequities persist nonetheless.

The shortfall in not only educational but social equality is perhaps most evident in the representation of blacks and other minorities in the professional and managerial ranks of business and industry. In the 1970 census, the Census Bureau reported that of the 11.5 million persons engaged in professional and technical occupations 875,000 (7 percent) were black or Spanish-speaking. Of the 8.4 million persons holding managerial and administrative positions, 312,000 (3.7 percent) belonged to these two minority groups. Yet these two minority groups comprise 13 percent of the total work force-- thus, they are nearly 50 percent underrepresented in the professional and technical category and more than 70 percent short in the managerial and administrative category.

For black males the Census Bureau statistical picture is even bleaker. In 1970 they held only 237,000 professional and technical positions compared to 374,000 positions in this category held by black women. The percentage of black males in these jobs was 5.9 percent of the total male work force, and represented only a slight gain over 1960.

While there are many contributing causes (e.g., racial and cultural discrimination) limiting upward mobility for minorities, lack of educational opportunity long has been singled out as a primary problem. Minorities are not alone in this respect. Today there is still a wide spectrum of differences among schools and colleges, ranging from very poor to very good, in the quality of teaching, the quality of facilities that profoundly affect the lives of Americans in all walks of life.

In one form or another, most deficiencies in the educational system are attributable to a lack of money to pay for better teachers and learning materials. The property tax is the primary form of support for secondary education and it has brought about sharp disparities in the quality of education being offered in the affluent suburbs and the poor inner city and rural school districts. Equalization of financial support by shifting to a general tax base is being debated in the courts and legislatures, but relief is not yet in sight.

Against this forbidding backdrop, we have posed the question: What can technology do about improving educational equality and opportunity?

At first glance it would seem technology can do very little without adequate funding. As we have indicated earlier technology will require an additional investment for development, to improve existing institutions

and to form the basis for the new "open" systems. On the other hand we can also assume, in the absence of contradictory evidence, that educational costs will continue to rise with or without this extra investment. The issue then is whether an investment in technology would be a wise one.

For reasons already discussed in this study, there can be no conclusive answer to this question until technology is adequately tested economically and educationally. But we would like to reiterate that technology does offer options for widening access and enhancing the quality of education. These options lie in the development of materials for the "open" systems and in properly applying tools such as television and the computer to free up the live teacher's time to give more attention to individual learner's problems. Technology also may be able to attack some of the specific educational problems holding back minorities.

Technology in "Hard" Subjects

Smith has stated that of the people in the top 20 percent of the General Electric Company's salaried ranks "more than 60 percent have a four-year technical degree."[6/] To move into the upper echelons of manufacturing, marketing and business generally requires a technical background. Therefore, when we consider how to increase minority representation in the professional and managerial ranks, we are dealing

6/ Smith, J. Stanford, Senior Vice President, General Electric Company, "Needed: A Ten-Fold Increase in Minority Engineering Graduates" -- an address to the Engineering Education Conference, Crotonville, New York, July, 1972.

partly with a problem of making a technical education more attractive and easier to obtain.

In recent years, minority students have leaned more toward the social and behavioral sciences. One reason for this is an abiding interest in helping their own people. Another reason frequently cited by educators is the absence of a home or peer group environment which encourages minorities to elect a course of study that involves the more difficult subjects of advanced math, physics, and chemistry required to obtain a technical degree. Technical careers, it should be noted, also are being shunned by white students as evidenced by a recent sharp drop in engineering school enrollments. The Engineers Joint Council has predicted there will be an annual shortage of 10,000 engineers starting in 1975. If this trend is to be reversed, a technical education has to be made more alluring for everyone, not just minorities.

If one inducement must be an assurance that job opportunities do in fact lie at the end of four years of hard study, another equally important inducement must be new approaches to teaching the sciences and other "hard" subjects which will make them easier to learn.

It is here that educational technology can play an important role--in taking more imaginative and interesting approaches to these subjects; in providing alternative approaches to problem solving--not just insisting that students learn the way the classroom teacher was taught; and in allowing students greater latitude to become involved with the subject matter.

New teaching-learning approaches are particularly needed in high school when students traditionally become "turned off" on the sciences. Moreover, educational technology should explore new ways to teach subjects preparatory to medical and legal careers, two other professions seriously underrepresented by minorities.

There are, of course, other problems faced by minorities in pursuing technical/professional educations. Many need financial support. If they go to predominantly white colleges and universities, many need special instruction in how to survive academically. Faculties must be sensitive to the unique handicaps minority students bring with them. It is probable that educational technology through information and systems engineering approaches can assist in this area by facilitating the process of drawing sharper academic "profiles" of students, predicting where they need more individualized instruction, and prescribing how to go about it.

These innovations undoubtedly will be expensive. But in the long run they will be self-repaying, if far greater numbers of minorities are able to participate equally in the nation's economy and in society as a whole.

Aiding the Disadvantaged

In its present form educational technology does not offer any panaceas for coping with the problems of the hard core disadvantaged, the millions of minorities and whites imprisoned by poverty. However, technology has demonstrated its potential for communicating new ideas and for providing opportunities to instruct and motivate the young. A recent study for the Children's Television Workshop showed that Sesame Street, in four

years of broadcasting, has gained an impressive following among ghetto children in New York, Chicago and Washington, D.C.[7/] A sampling of a total of 1,217 households in ghetto households which were 99 percent black or Puerto Rican disclosed the following penetration: in New York, Bedford Stuyvesant 92 percent and East Harlem 94 percent; Chicago 97 percent; Washington, D.C., 67 percent. The percentage of regular pre-school and school-age viewers in these households has increased substantially since the program started. From 84 to 92 percent of the mothers in the three cities praised the program for making a major difference in their children's ability to read, count and prepare them for school.

Sesame Street has attained an estimated regular audience of 9 million children nationwide and the Workshop's two-year-old The Electric Company reaches about 6 million children--roughly half of them in school, according to the survey.

These results, particularly the following among the poor, are encouraging. But they are only a beginning. The real challenge to technology to aid the disadvantaged still lies ahead.

Much more can and should be done to build upon this beginning. There should be more advanced follow-on television programs directed at specific minority groups (e.g. blacks, Puerto Ricans, Mexican Americans, American Indians, Asian Americans) to further improve reading, language and study skills in school. Research should be performed

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7/ Daniel Yankelovich Inc. "Study on the Role and Penetration of Sesame Street and The Electric Company in Ghetto Communities." April, 1973.

to learn how to capitalize on the cognitive skills that have been tapped by Sesame Street and The Electric Company. Are there learning continuities that can be further exploited?

As stated earlier, research is needed into learning handicaps of the disadvantaged that result from nutritional and environmental deficiencies. This research should be both basic and applied and cover the wide range of needs and individual differences in learning skills at all school age levels. Technology should be developed on the basis of this research to create highly individualized learning resources where indicated.

Technology is severely limited in what it can hope to accomplish in offsetting handicaps arising from a deprived home, where there are many children, no father in the house, little food, sometimes no clothing for youngsters to wear to school, and little parental concern whether a child is educated. What these children often need most is affection and understanding, from a teacher who can imbue them with a sense of personal worth. All too frequently depersonalized formal schools do not take into account physical and emotional problems that handicap learning and the disadvantaged child quickly becomes labeled a failure, further sapping his motivation to achieve.

In dropout prevention programs sponsored by the Office of Education and in remedial education systems such as California's continuation schools heavy reliance is being placed upon individualized instruction utilizing a combination of teachers and technology.[8/] Some programs

8/ Howard, W. E., Dropouts: Prevention and Rehabilitation, National School Public Relations Association, Washington, D.C., 1972.

employ "no fail" curricula that allow a student to work at a task until it is mastered. There also is a strong emphasis in the last two years in high school on work-study in which students have part-time jobs during the school day. While documentation of the success rates of these programs is rather sketchy, there is suggestive evidence that involving student interests in the world of work does stimulate learning and is a positive factor in pupil retention.

The potential of educational technology in this area needs to be investigated further. The requirements listed above suggest the possible application of hands-on computer terminals for teaching problem solving; computers for the management of instruction and record-keeping on individual performances; development of special, modular material easily adaptable to individualized instruction; and the development of special materials to further stimulate acquisition of vocational, mathematics, reading and language skills--perhaps employing the audio-tutorial method.

Instructional technology can be improved to speed up and broaden the reach of vocational training. Currently, much vocational or career training appears to be rather traditional in methodology compared to that in industry and the military. A systematic analysis of the problem should produce more potential for the audio-tutorial method of self-instruction; there also is more potential for material such as films to acquaint young people with opportunities in the vocational field.

Reduction of the unemployed and under-employed

To help people adapt to rapid changes in our society, there is a need for programs to retrain semi-skilled and skilled workers for new jobs. There is also a need to raise the performance levels of individuals so that they can successfully undertake jobs requiring higher levels of skills. Special attention needs to be given to the unskilled unemployed. They should not be regarded as uneducable. Often lack of motivation or lack of self-confidence is a problem.

Educational technology, appropriately employed, has the potential to provide individual, on-the-job training for those who need it. T.V. can be used to reach, motivate and train some of the unemployed at home. However, this will require new types of materials and programs.

Overview

In summary, technology can and must play a stronger role in educating and training the disadvantaged, the handicapped, the unemployed, the underemployed as well as vocational students. But this role is dependent upon more research and the development of techniques proved to be effective in coping with the peculiar needs of these groups.

To this effect, we recommend that a categorical program of the U.S. Office of Education be funded at a sufficient level, and with a guarantee of support for a sufficiently long period of time, to provide research and pilot studies as to how technology can be effective in the delivery of education to the deprived, the handicapped, the unemployed, the underemployed, and vocational students.

We further recommend that the proposed National Open Education Corporation be mandated to consider from the beginning of its operation the delivery of education to these groups.